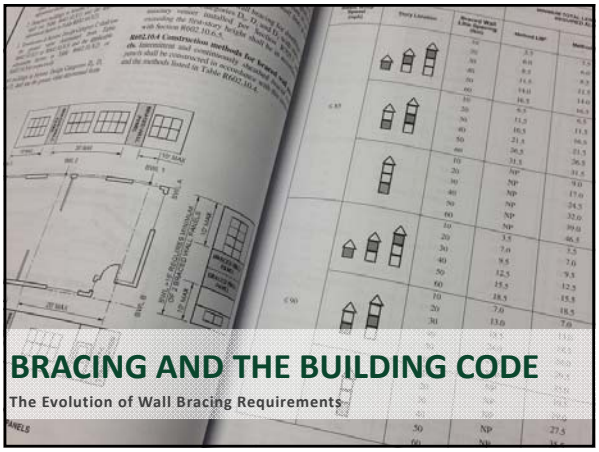


1778 B.C. – Code of Hammurabi

"If a…house falls and kills the householder, the builder shall be slain.

"If…the walls shift, then the builder shall make that wall good with his own silver."

10

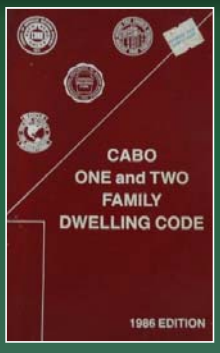
1927 – Uniform Building Code

"Buildings…shall be of sufficient strength to support the estimated or actual imposed dead and live…"

11

1986 - CABO

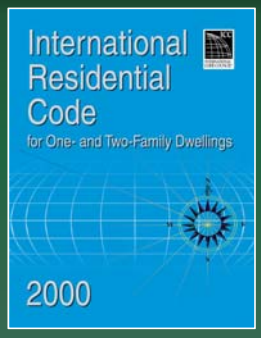
- Wall bracing methods
  - Let in bracing
  - 48" structural sheathing
    - Plywood
    - Particleboard
    - Fiberboard
    - Gypsum board



12

2000 – International Residential Code

- Wall bracing
- 8 bracing methods
- Exception for continuous sheathing
- Wind bracing amounts based on seismic loads



13

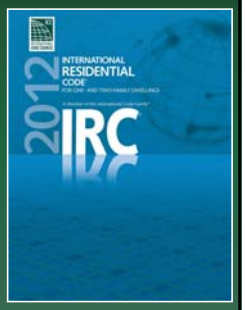
2007-2010 - ICC Ad Hoc Committee

- Resolve discrepancies:
  - Make easier to understand
  - Provide flexibility
  - Separate wind and seismic
- Members representing:
  - Academics
  - Code officials
  - Industry representatives
  - Home builders
- Proposed changes first appeared in the 2009 IRC

14

2012 – International Residential Code

- 16 bracing methods
- 4 narrow panels
- Wind and seismic separated
- Increased flexibility (with increased complexity)
- Simplified approach added



15

Why Change?
The Evolution of House Size

1950s 1960s

1970s 1980s

1990s 2000s

16

Why Change?
Design Trends

Open Concept

High Ceilings

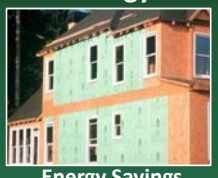
Two story Walls

Natural Light Windows

17

Why Change?
New Methods and Technology

Narrow Walls

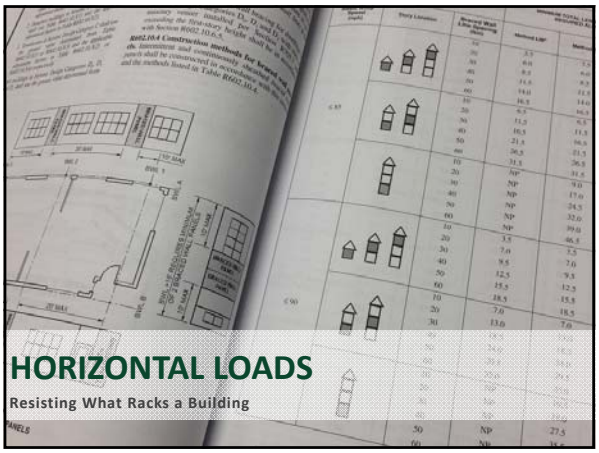


Energy Savings

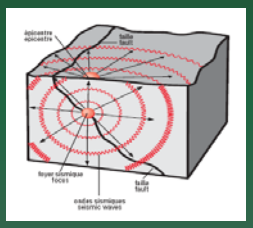
Hardware

Materials

18



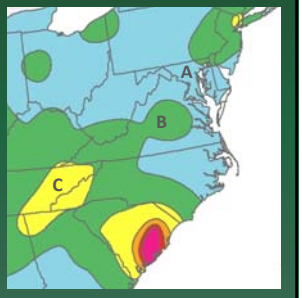
Seismic Load



22

Seismic Design Category

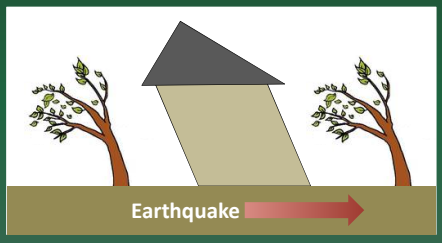
- Based on:
  - Ground movement severity
  - Occupancy category



R301.2.2

23

Seismic Forces



26

Wind Load

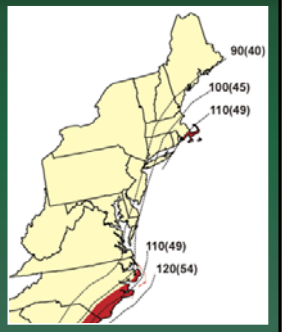
Hurricane Isabel 2003

Derecho 2012

28

Wind Speed

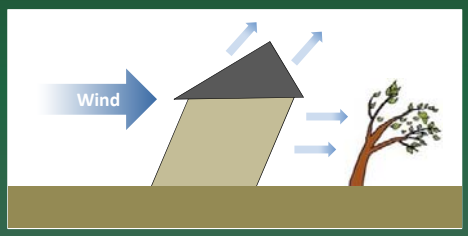
- Wind speed based on:
  - 3 second gust
  - 50 year storm
  - 30 feet above grade
- Regional wind speed: 90 100 mph
- Equivalent to mid grade Category 1 hurricane



R301.2.1

29

Wind Load

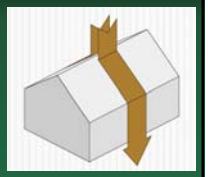


31

Load Path

DEFINITION: The route a force travels from the area where it is applied to the ground.

Vertical forces



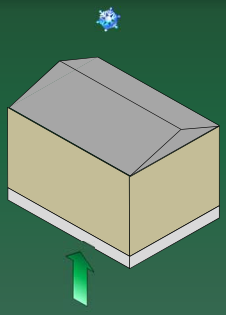
Horizontal forces

32

Vertical Load Path

Vertical load path transfers gravity load:

- to roof sheathing
- to rafters/trusses
- to walls
- to foundation
- to ground

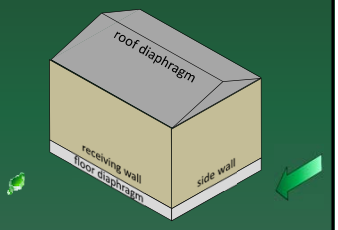


33

Horizontal Load Path

Horizontal load path transfers wind load:

- to receiving wall
- to diaphragms
- to side walls
- to foundation
- to ground

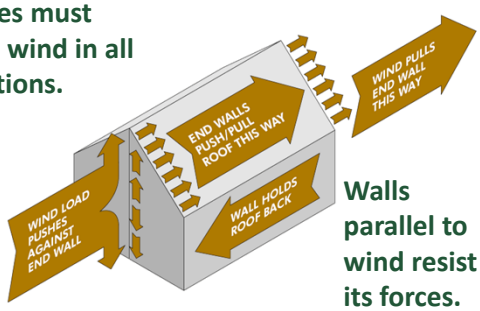


DIAPHRAGM: the sheathing of the roof or floor which acts as a thin, deep beam delivering lateral forces to the main wind force resisting system (MWFRS).

34

Horizontal Load Path

Houses must resist wind in all directions.



Walls parallel to wind resist its forces.

35

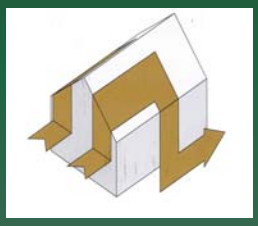
Multi-story House

- Wind load accumulates from top to bottom
- 1st floor walls resist greatest load
- Largest openings in 1st floor

37

Critical Elements of Load Path

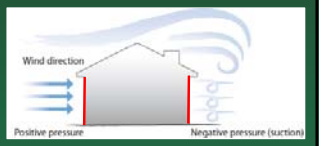
- Load travels through the following key elements:
  - Receiving/suction walls
  - Connections
  - Diaphragms
  - Wall bracing
- Each element has:
  - Specific purpose
  - Areas of focus
  - Failure ramifications



38

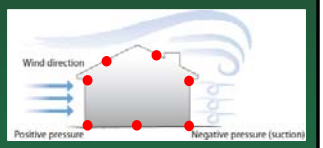
Critical Element of Load Path
Receiving wall, suction wall

- Purpose:
  - Captures load
  - Delivers load to diaphragm
- Area of focus:
  - Sheathing/siding
  - Sheathing to stud fasteners
- Failure causes…
  - Weather intrusion



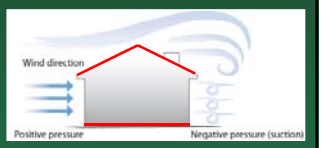
Critical Element of Load Path
Connections

- Purpose:
  - Transfers load
- Area of focus:
  - Fasteners
  - Anchor bolts
- Failure causes…
  - Weather intrusion
  - Collapse



Critical Element of Load Path
Diaphragms

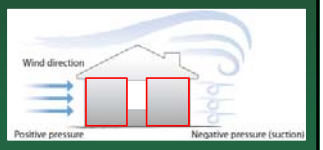
- Purpose:
  - Delivers load to side walls
- Area of focus:
  - Sheathing to rafter/truss fasteners
  - Sheathing to joists fasteners
- Failure causes…
  - Weather intrusion



41

Critical Element of Load Path
Wall Bracing

- Purpose:
  - Resists load
  - Transfers load to foundation



42

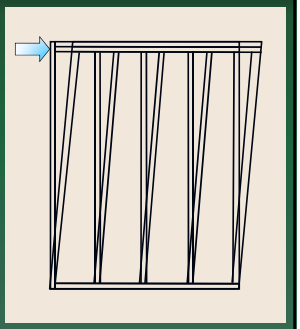
Critical Element of Load Path
Wall Bracing

- Purpose:
  - Resists load
  - Transfers load to foundation
- Failure modes:
  - Sliding
  - Overturning
  - Racking

43

How Bracing Works

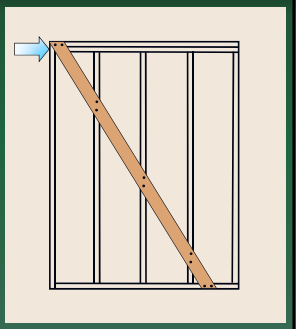
- Horizontal load at top plate (from diaphragm)
- Without bracing
  - Wall has no stiffness
  - Wall racks



44

How Bracing Works

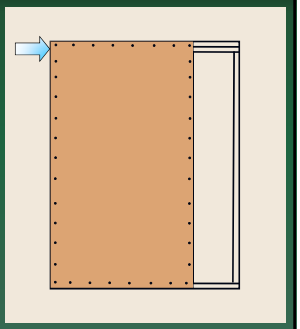
- Horizontal load at top plate (from diaphragm)
- Without bracing
  - Wall has no stiffness
  - Wall racks
- Add bracing, add stiffness:
  - Let in



45

How Bracing Works

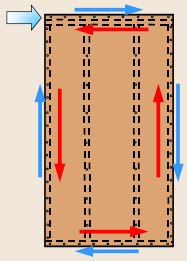
- Horizontal load at top plate (from diaphragm)
- Without bracing
  - Wall has no stiffness
  - Wall racks
- Add bracing, add stiffness:
  - Let in
  - Solid rectangular panels



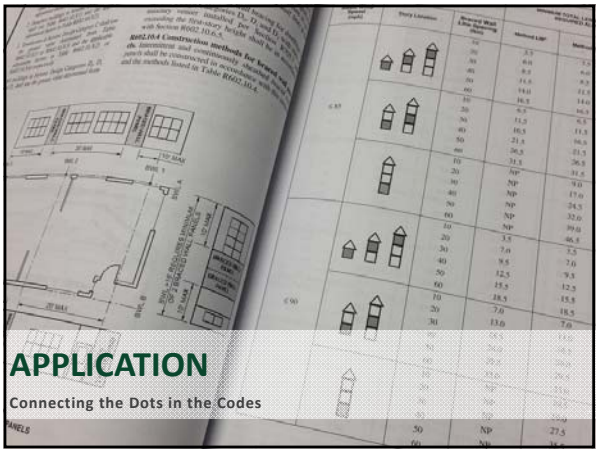
46

Resisting Racking

- Edge nails
  - Resist horizontal load
  - At closer spacing
- Field nails
  - Resist buckling
  - Wider spacing



47



Options for Resisting Horizontal Load

- IRC prescriptive solution
- Other prescriptive solutions
- Engineered design
- Pre engineered proprietary products

53

The Prescriptive Code

- IRC is a cookbook
- Recipes based on
  - Historical performance
  - Common materials
  - Nationwide application
- Follow recipe no RDP
- Fall outside recipe RDP required

The worst house you can build by law!

54

IRC Project Types

- New detached single family dwellings
- Townhouses
- Additions
- Conversions:
  - Decks to sunrooms
  - Carports to garages
  - Porches to living spaces

IRC Wall Bracing Limitations

- Wood framed construction
- Maximum 3 stories
- Wind speeds < 110 mph
- SDC A D_2
- Wall height ≤ 12 feet
- Roof height (from eave to ridge) ≤ 20 feet

R602.10

56

Alternate Prescription Solutions

- Wood Frame Construction Manual 2012
- WFCM Guide for high wind areas
- ICC 400 (for log structures)
- IBC Chapter 23

R301.1.1

57

Engineered Design

- Shear walls
- When design exceeds limits of IRC
- Accepted engineering practice"
- May be portion or entire structure
- Reference IBC

R301.1.3

58

Shear Wall Standards

- ASCE 7 to determine wind load on MWRS

MWFRS: (main wind force resisting system) the structural elements in the horizontal load path which resist load.

IBC 1609.1.1

59

Shear Wall Standards

- SDPWS as design standard
- Design requirements for shear walls, diaphragms
- Table 4.3.4:

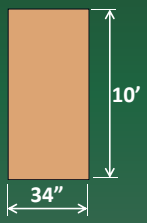
Shear Wall Sheathing Type (blocked, unless noted otherwise)	Maximum Aspect Ratio
Wood structural panels, unblocked	2:1
Wood structural panels	3.5:1
Particleboard	2:1
Diagonal sheathing, conventional	2:1
Gypsum wallboard	2:1
Portland cement plaster	2:1
Structural fiberboard	3.5:1

IBC 2305.1

60

Shear Wall Standards

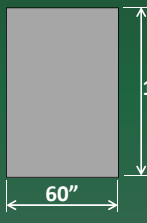
Wood Structural Panels
aspect ratio 3.5:1



120 ÷ 3.5 34”

Height	8’	9’	10’	11’	12’
Length	27”	31”	34”	38”	41”

Portland Cement Plaster Panels
aspect ratio 2:1

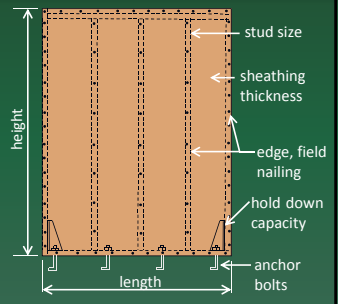


120 ÷ 2.0 60”

Height	8’	9’	10’	11’	12’
Length	48”	54”	60”	66”	72”

Engineered Shear Walls

- Stud size, spacing
- Sheathing type, thickness
- Fastening schedule
- Hold down requirement, capacity
- Anchor bolt location, capacity

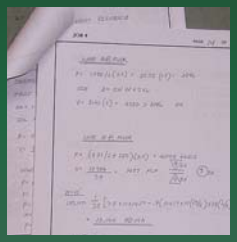


62

Engineered Shear Walls

TIP: When submitting or reviewing engineered calculations, look for…

- Wind load determination (13 18 psf in 90 mph, V_{ult} 115 mph)
- Seal of registered design professional
- Minimum aspect ratio



63

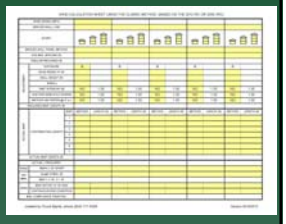
Engineered Moment Frame

- Engineered solution
- Requires calculations
- Types:
  - Custom
  - Pre designed
    - Hardy Frame
    - Simpson Strong Tie
- Used often in townhouses

64

Bracing Information

- Bracing elements shown on plans
  - BWPs
  - BWLs
  - Circumscribed rectangles
- Analysis may be required
  - Forms
  - Spreadsheet
  - Calculations



VCC 109.3, R602.10 & R602.12

65

Relaxed Plan Review

- At discretion of the building official
- No review of 2nd floor wall bracing if:
  - 1st floor analysis correct, and
  - 2nd floor openings less than walls directly below

R602.10 & R602.12 66

Relaxed Plan Review

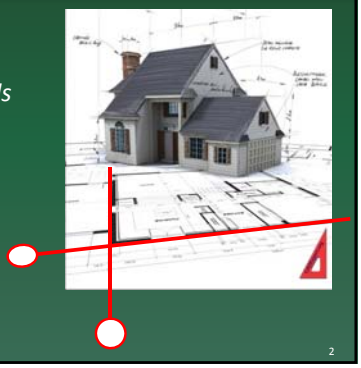
R602.10 & R602.12 67

Relaxed Plan Review

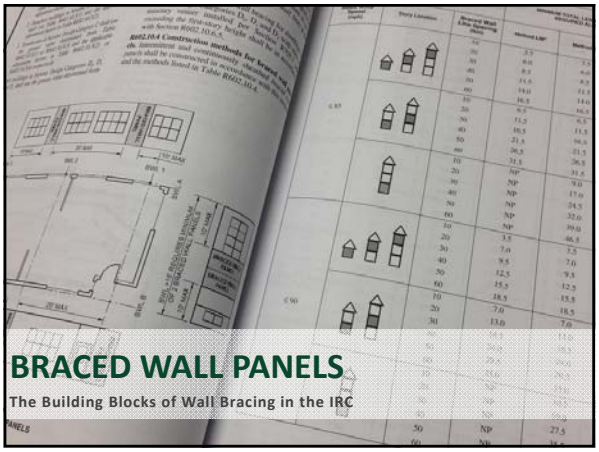
R602.10 & R602.12 68

"Classic" Wall Bracing

- *Braced Wall Lines* (BWL)
- *Braced Wall Panels* (BWP)
- Greater flexibility
- More complex

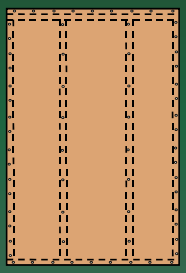


R602.10 2



Braced Wall Panel

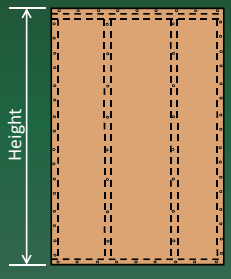
DEFINITION: A full height section of wall constructed to resist horizontal loads with a minimum panel length.



R602.10.2 4

Braced Wall Panel

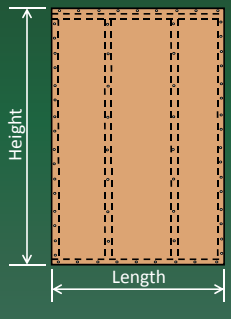
- Full height, 12' maximum



R602.10.2 5

Braced Wall Panel

- Full height, 12' maximum
- Minimum length based on bracing method



R602.10.2 6

Braced Wall Panel

- Full height, 12’ maximum
- Minimum length based on bracing method
- No horizontal offsets

Not the same BWP

R602.10.2 7

Braced Wall Panel

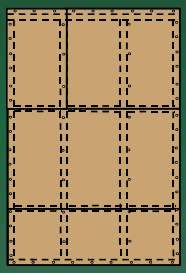
- Full height, 12’ maximum
- Minimum length based on bracing method
- No horizontal offsets
- No vertical offsets

Not the same BWP

R602.10.2 8

Braced Wall Panel

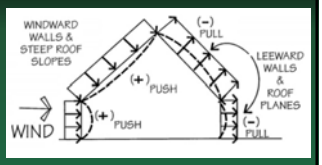
- Full height, 12’ maximum
- Minimum length based on bracing method
- No horizontal offsets
- No vertical offsets
- Vertical, horizontal joints permitted (same material)
  - Studs at vertical joints
  - Blocking at horizontal joints

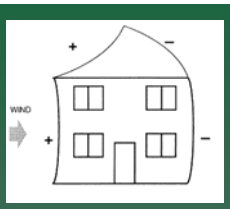


R602.10.10 9

Uplift Load Path

- All BWPs must have connections to resist uplift
- Use standard fasteners per Table R602.3(1) for:
  - 90 mph, exposure B
  - ≥ 5:12 roof pitch
  - ≤ 32’ roof span





R602.3.5 10

Uplift Load Path

- Use Table R802.11 to determine uplift load at each rafter/truss

TABLE R802.11
RAFTER OR TRUSS UPLIFT CONNECTION FORCES FROM WIND (POUNDS PER CONNECTION)

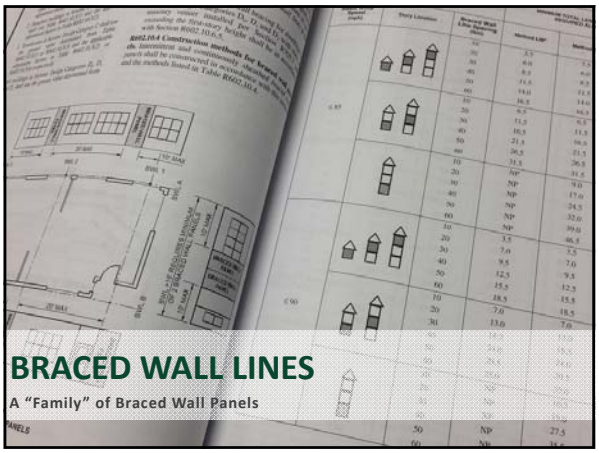
RAFTER OR TRUSS SPACING	ROOF SPAN (feet)	EXPOSURE B, Basic Wind Speed (mph) 85		90		100		110	
		Roof Pitch		Roof Pitch		Roof Pitch		Roof Pitch	
		< 5:12	≥ 5:12	< 5:12	≥ 5:12	< 5:12	≥ 5:12	< 5:12	≥ 5:12
24" o.c.	12	94	82	124	108	196	162	254	221
	18	117	102	155	135	218	207	329	286
	24	140	122	186	162	290	252	404	351
	28	154	134	208	181	326	284	454	395
	32	170	148	230	200	313	504	438	
	36	186	162	252	219	396	345	554	482
	42	209	182	285	248	449	391	630	548
	48	232	202	318	277	502	437	706	614

R602.3.5 11

Uplift Load Path

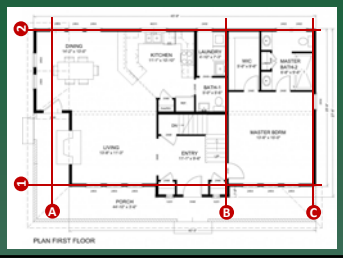
- Convert to lbs/ft, plf:
  - Tabular value (lbs) ÷ rafter/truss spacing (ft)
  - Example: 396 lbs ÷ 2 ft 198 plf
- Subtract weight of floors above:
  - Each floor 60 plf
  - Example for 1st of two story house: 198 – 60 138 plf
- If final value exceeds 100 plf:
  - Provide connectors to resist uplift or
  - Design by RDP

R602.3.5 12



Braced Wall Line

DEFINITION: An imaginary straight line though the building which represents the centerline of lateral resistance provided by parallel BWPs.



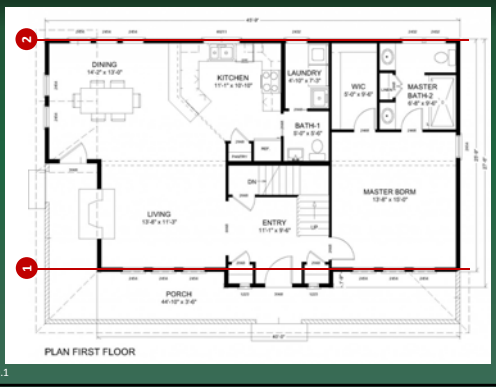
R602.10.1 18

Six Rules for BWLs

1. **STRAIGHT LINES:**
   BWLs cannot curve, bend or jog
2. **EACH PLAN DIRECTION:**
   BWLs go up/down and left/right
3. **ALL FLOORS:**
   Each floor level requires BWLs
4. **PERMITTED TO FLOAT:**
   BWLs are not required to be on actual walls
5. **DEFINED ENDS:**
   BWLs have a starting and ending point
6. **MAXIMUM SPACING:**
   Spacing between parallel BWLs is limited

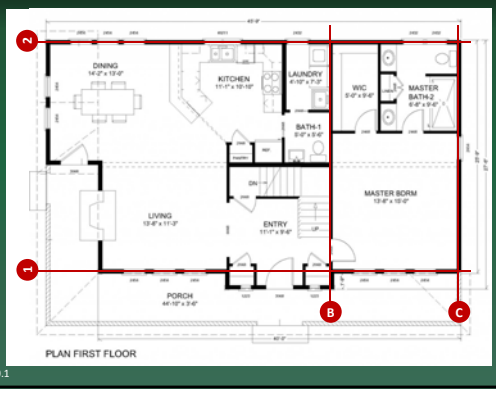
19

Rule 1: Straight line



R602.10.1 20

Rule 2: Each Plan Direction

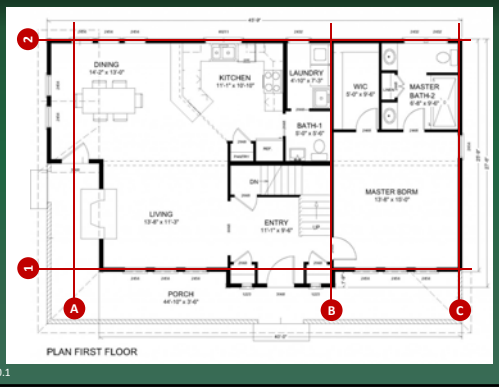


R602.10.1 21

Rule 3: All Floors

R602.10.1 22

Rule 4: Permitted to Float

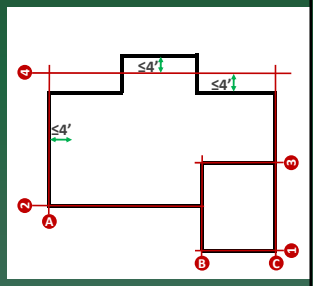


R602.10.1 23

Rule 4: Permitted to Float

BWLs are not required to align with actual walls such that…

- BWLs can "float between walls
- Parallel BWPs within 4' apply to BWL
- BWLs can be offset from entire wall

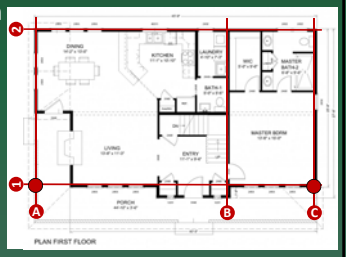


R602.10.1.2 24

Rule 5: Defined Ends

DEFINITION: The end of a BWL is defined as the…

- Intersection with another BWL



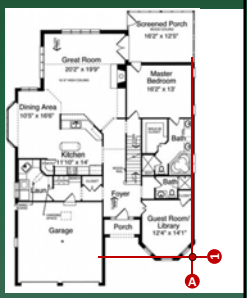
Intersection

R602.10.1.1 25

Rule 5: Defined Ends

DEFINITION: The end of a BWL is defined as the…

- Intersection with another BWL
- Projected intersection at chamfered corner



Chamfered corner

R602.10.1.1 26

Rule 5: Defined Ends

DEFINITION: The end of a BWL is defined as the…

- Intersection with another BWL
- Projected intersection at chamfered corner
- Intersecting basement walls

Walkout basement

R602.10.1.1 27

Rule 5: Defined Ends

DEFINITION: The end of a BWL is defined as the…

- Farthest exterior wall
- Or combination thereof

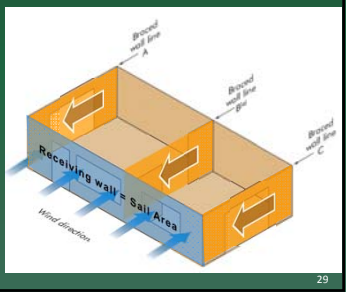
Discontinuous second floor

R602.10.1.1 28

Rule 6: Maximum Spacing

DEFINITION: The average distance between parallel BWPs.

- Sail area governs BWL spacing
- BWPs on BWLs resist parallel wind load
- Determined by Table R602.10.1.3



R602.10.1.3 29

Rule 6: Maximum Spacing

TABLE R602.10.1.3
BRACED WALL LINE SPACING

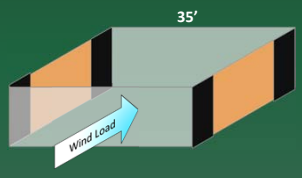
APPLICATION	CONDITION	BUILDING TYPE	BRACED WALL LINE SPACING CRITERIA	
			Maximum Spacing	Exception to Maximum Spacing
Wind bracing	85 mph to < 110 mph	Detached, townhouse	60 feet	None
Seismic bracing	SDC A – C	Detached	Use wind bracing	
	SDC A – B	Townhouse	Use wind bracing	
	SDC C	Townhouse	35 feet	Up to 50 feet when length of required bracing per Table R602.10.3(3) is adjusted in accordance with Table R602.10.3(4).
	SDC D_0, D_1, D_2	Detached, town-houses, one- and two-story only	25 feet	Up to 35 feet to allow for a single room not to exceed 900 square feet. Spacing of all other braced wall lines shall not exceed 25 feet.
	SDC D_0, D_1, D_2	Detached, townhouse	25 feet	Up to 35 feet when length of required bracing per Table R602.10.3(3) is adjusted in accordance with Table R602.10.3(4).

- Local wind zones: 90 mph, 100 mph
- Maximum spacing between parallel BWLs 60’
- SDC A and B: design for wind

R602.10.1.3 30

Braced Wall Line Spacing

Larger sail areas require more bracing.



R602.10.1.3 36

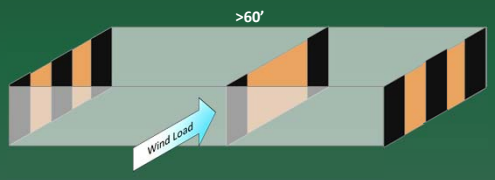
Braced Wall Line Spacing

Larger sail areas require more bracing.

R602.10.1.3 37

Braced Wall Line Spacing

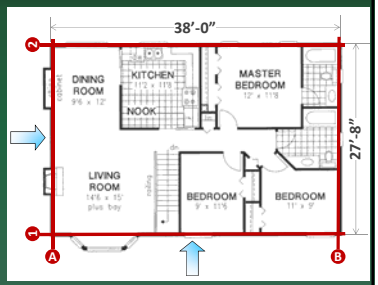
Larger sail areas require more bracing.



R602.10.1.3 38

Braced Wall Line Spacing

- BWLs share load
- Example:
  - A & B share load in N/S direction
  - 1 & 2 share load in E/W direction



R602.10.1.3 39

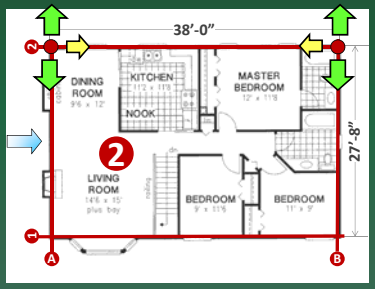
How to Determine BWL Spacing

- Use average spacing if adjacent BWLS have differing dimensions
  - Check the spacing from both sides at each end
  - Average the values measured

Tab e R602.10.3(1), Footnote C

40

BWL Spacing: "Where's my help?"

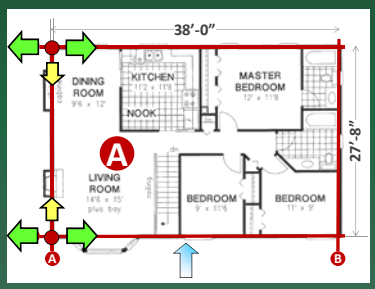


BWL spacing = 27.67'

R602.10.1.3

41

BWL Spacing: "Where's my help?"

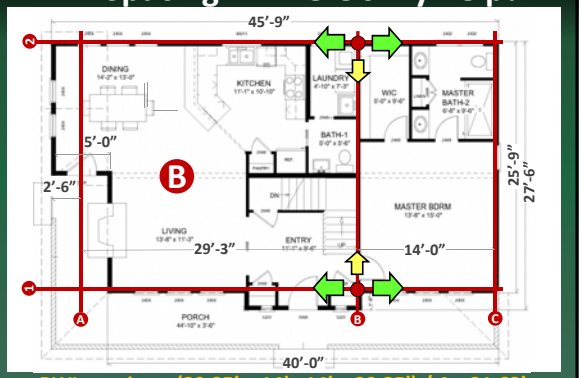


BWL spacing = 38'

R602.10.1.3

42

BWL Spacing: "Where's my help?"

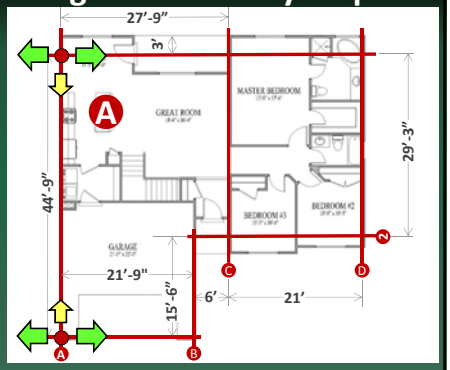


BWL spacing = (29.25' + 14'+ 14' + 29.25') / 4 = 21.63'

43

BWL Spacing: "Where's my help?"

- Side a
  NA
- Side b
  21.75
- Side c
  27.75
- Side d
  NA

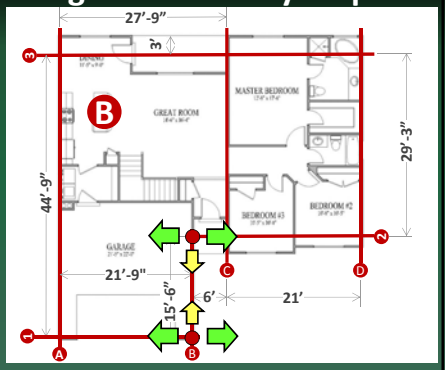


BWL spacing = (21.75 + 27.75) / 2 = 24.75'

44

BWL Spacing: "Where's my help?"

- Side a
  21.75
- Side b
  NA
- Side c
  6
- Side d
  21.75

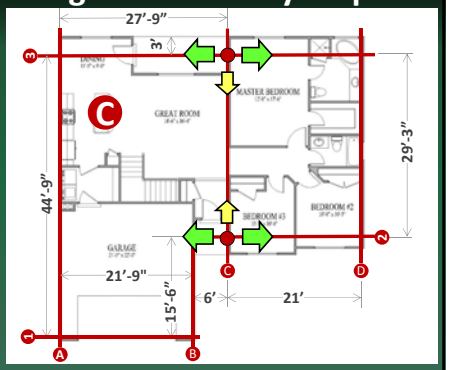


BWL spacing = (21.75 + 6 + 21.75) / 3 = 16.5'

45

BWL Spacing: "Where's my help?"

- Side a
  6
- Side b
  21
- Side c
  21
- Side d
  27.75

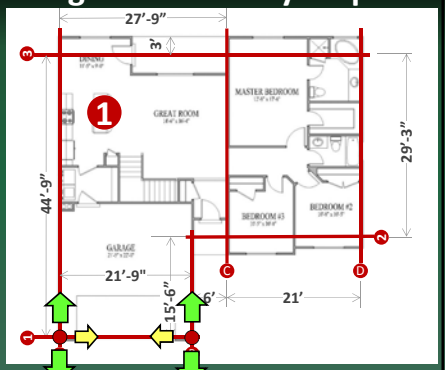


BWL spacing = (6 + 21 + 21 + 27.75) / 4 = 18.94'

46

BWL Spacing: "Where's my help?"

- Side a
  44.75
- Side b
  NA
- Side c
  NA
- Side d
  15.5

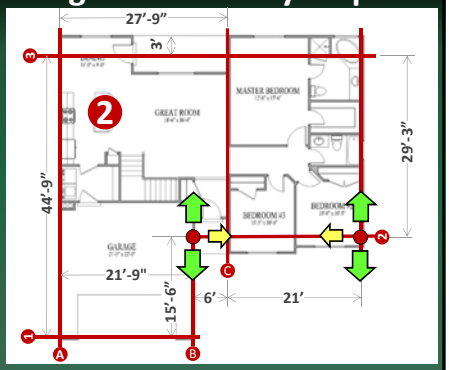


BWL spacing = (44.75 + 15.5) / 2 = 30.13'

47

BWL Spacing: "Where's my help?"

- Side a
  29.25
- Side b
  15.5
- Side c
  NA
- Side d
  29.25

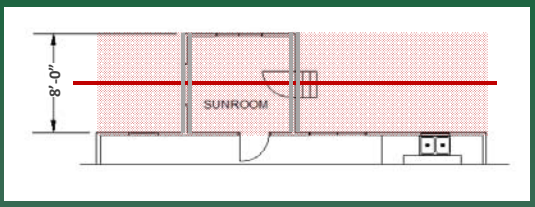


BWL spacing = (29.25 + 15.5 + 29.25) / 3 = 24.67'

48

Braced Wall Lines

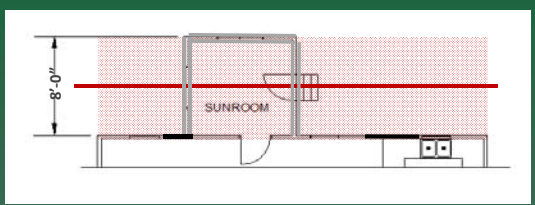
- TIP: Consider a BWL to be the centerline of an 8' wide "braced wall band" where any perpendicular walls located completely within the band are not required to be braced.



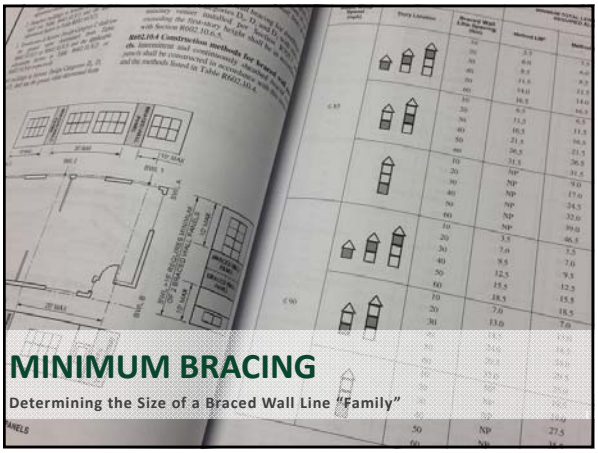
49

Braced Wall Lines

- TIP: If placing BWPs strategically, all walls in a sunroom can be glass.



50



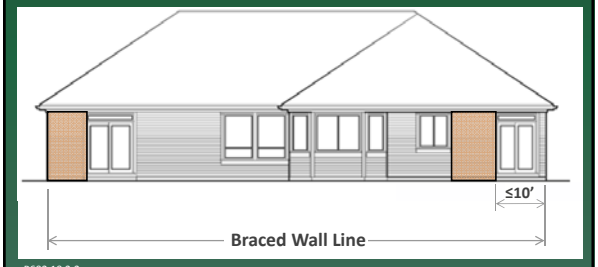
Four Rules for BWPs on a BWL

1. **LOCATION:**
   BWPs must be located at each end
2. **SPACING:**
   BWPs cannot exceed a maximum spacing
3. **QUANTITY:**
   BWLs require a minimum number of BWPs
4. **CUMULATIVE LENGTH:**
   Total length of BWPs must exceed code value

R602.10.2, R602.10.3 58

Rule 1: BWP Location on a BWL

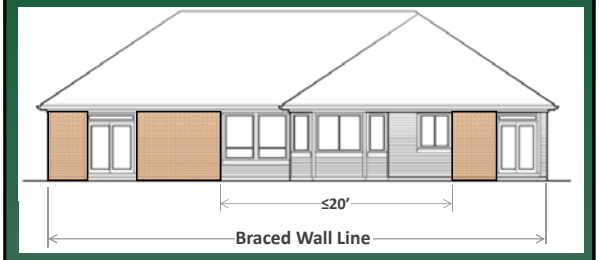
- Located at BWL end , or
- Begins within 10’ of BWL end



R602.10.2.2 59

Rule 2: BWP Spacing on a BWL

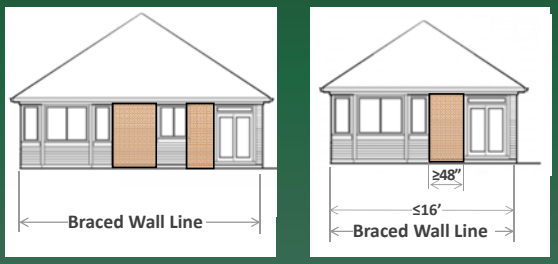
- BWPs cannot exceed a distance of 20’ edge to edge.



R602.10.2.2 60

Rule 3: Number of BWPs on a BWL

- BWLs must have a minimum of two BWPs
- Exception: BWLs ≤ 16’ can have one 48” BWP



R602.10.2.3 61

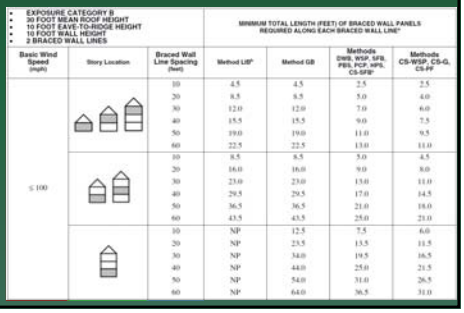
Rule 4: Cumulative Length

- Total length of BWPs must exceed code value
- Calculate using Tables R602.10.3(1) and (2)
- Following these steps:
  a) **Choose it!** Select value from table
  b) **Adjust it!** Multiply by adjustment factors
  c) **Compare it!** Actual length ≥ minimum length

R602.10.3 62

Choose It!

- Use Table R602.10.3(1)
- Known values:
  - Wind speed
  - Story location
  - BWL spacing
  - Bracing method



R602.10.3

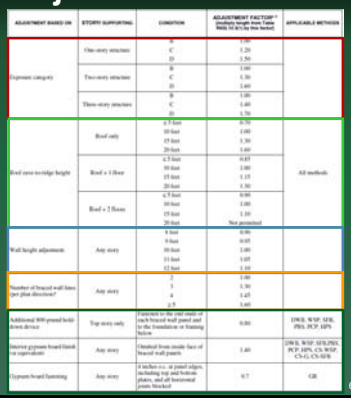
Choose It!

- EXPOSURE CATEGORY B
- 30 FOOT MEAN ROOF HEIGHT
- 10 FOOT EAVE-TO-RIDGE HEIGHT
- 10 FOOT WALL HEIGHT
- 2 BRACED WALL LINES

Basic Wind Speed (mph)	Story Location	Braced Wall Line Spacing (feet)	MINIMUM TOTAL LENGTH (FEET) OF BRACED WALL PANELS REQUIRED ALONG EACH BRACED WALL LINE[a]			
			Method LIB[b]	Method GB	Methods DWB, WSP, SFB, PBS, PCP, HPS, CS-SFB[c]	Methods CS-WSP, CS-G, CS-PF
≤ 100		10	4.5	4.5	2.5	2.5
		20	8.5	8.5	5.0	4.0
		30	12.0	12.0	7.0	6.0
		40	15.5	15.5	9.0	7.5
		50	19.0	19.0	11.0	9.5
		60	22.5	22.5	13.0	11.0
		10	8.5	8.5	5.0	4.5
		20	16.0	16.0	9.0	8.0
		30	23.0	23.0	13.0	11.0
		40	29.5	29.5	17.0	14.5
		50	36.5	36.5	21.0	18.0
		60	43.5	43.5	25.0	21.0
		10	NP	12.5	7.5	6.0
		20	NP	23.5	13.5	11.5
		30	NP	34.0	19.5	16.5
		40	NP	44.0	25.0	21.5
		50	NP	54.0	31.0	26.5
		60	NP	64.0	36.5	31.0

Adjust It!

- Use Table R602.10.3(2)
- Choose adjustments for:
  - Wind exposure
  - Roof height
  - Wall height
  - No. of BWLs
  - More



R602.10.3 65

Adjust It! - Wind Exposure

Exposure category	One story structure	B	1.00
		C	1.20
		D	1.50
	Two-story structure	B	1.00
		C	1.30
		D	1.60
	Three-story structure	B	1.00
		C	1.40
		D	1.70

Category B
Urban suburban
Wooded

Category C
Open terrain
Grasslands, flat plains
Wind flows over open water for 1,500 feet

Category D
Unobstructed, flat
Wind flows over open water for 1 mile

R602.10.3 66

Adjust It! - Wind Exposure

TIP: Houses located on a lake or reservoir with open water for 1,500 feet or more, requires Exposure Category C.

R602.10.3 67

Adjust It! – Eave-to-Ridge Height

Roof eave-to-ridge height	Roof only	≤5 ft	0.70
		10 ft	1.00
		15 ft	1.30
		20 ft	1.60
	Roof + 1 floor	≤5 ft	0.85
		10 ft	1.00
		15 ft	1.15
		20 ft	1.30
	Roof + 2 floors	≤5 ft	0.90
		10 ft	1.00
		15 ft	1.10
		20 ft	Not permitted

Flat, very low slope

Low slope, up to 10 feet

Steep slope

R602.10.3 68

Adjust It! – Wall Height

Wall height adjustment	Any story	8 ft	0.90
		9 ft	0.95
		10 ft	1.00
		11 ft	1.05
		12 ft	1.10

Shorter walls

10-foot walls

Tall walls

R602.10.3 69

Adjust It! – Number of BWLs

Number of braced wall lines (per plan direction)[c]	Any story	2	1.00
		3	1.30
		4	1.45
		≥5	1.60

- Number of BWLs in <u>one</u> plan direction
- Value adjusts for larger building with more BWLs.

2 BWLs 1.00 **3 BWLs** 1.30 **4 BWLs** 1.45 **≥5 BWLs** 1.60

R602.10.3 70

Adjust It! – Number of BWLs

TIP: When placing BWLs, consider the following:

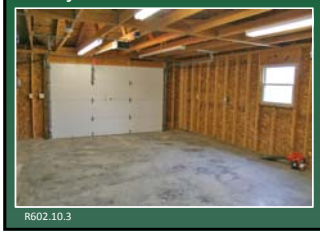
- **Place as few BWLs as possible**
- **BWLs that penetrate the entire house are the most efficient**
- **Placing BWLs can be an iterative process**

R602.10.3 71

Adjust It! – No Interior Finish

Interior gypsum board finish (or equivalent)	Any story	Omitted from inside face of braced wall panels	1.40	DWB, WSP, SFB, PBS, PCP, HPS, CS-WSP, CS-G, CS-SFB

- For unfinished areas
- Limited methods
- Adjustment factor 1.40



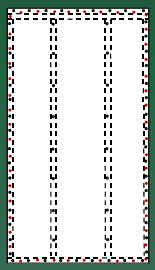
R602.10.3 72

Adjust It! – Fastener Spacing

Fastener spacing	Any story	4 in. o.c. at panel edges, including top and bottom plates, an all horizontal joints blocked	0.7	GB
			0.83	WSP, CS-WSP

- Limited methods
- Reduce edge spacing to 4” o.c.
- Adjustment factor:
  - 0.7 for GB
  - 0.83 for WSP, CS WSP*

*Virginia interpretat on only



R602.10.3 73

Adjust It!

- Adjusted required length of bracing the product of
  - Tabular value
  - Exposure category
  - Eave to ridge height
  - Wall height
  - Number of BWLs
  - No interior finish
  - Fastener spacing

Adjusted length = (tabular value) x (adjustment factor) x (adjustment factor) x (adjustment factor)…

R602.10.3 75

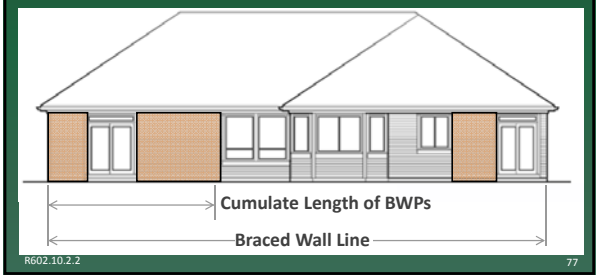
Adjust It!

- **TIP: When a BWL has more than one wall height, eave to ridge height, etc., adjust to the highest value for the required length of bracing.**

76

Compare It!

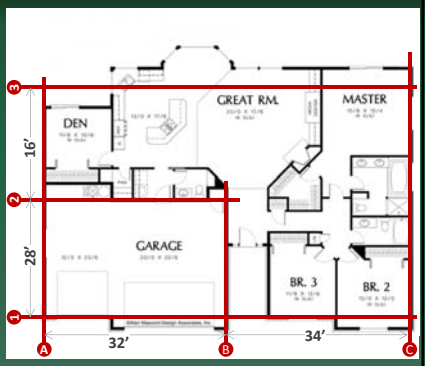
- Cumulative length of all BWPs contributing length
- Cumulative length ≥ Adjust length



R602.10.2.2 77

Example – Does BWL 3 Comply?

- 100 mph
- Farm house
- 15’ eave to ridge
- 10’ walls
- Finished interior
- Method WSP



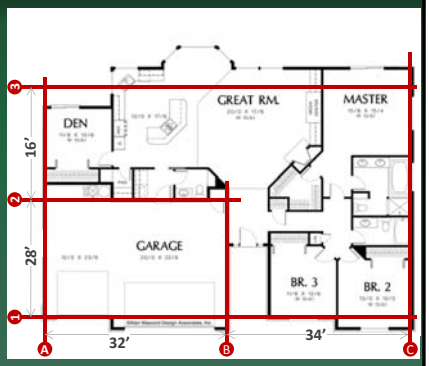
78

Example – Does BWL 3 Comply?

1) Determine BWL spacing

$$\frac{16+44}{2}$$

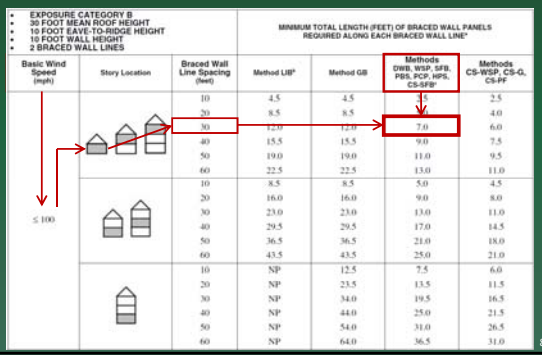
30’



79

Example

2) Choose it! Tabular value 7’



- EXPOSURE CATEGORY B
- 30 FOOT MEAN ROOF HEIGHT
- 10 FOOT EAVE-TO-RIDGE HEIGHT
- 10 FOOT WALL HEIGHT
- 2 BRACED WALL LINES

MINIMUM TOTAL LENGTH (FEET) OF BRACED WALL PANELS REQUIRED ALONG EACH BRACED WALL LINE*

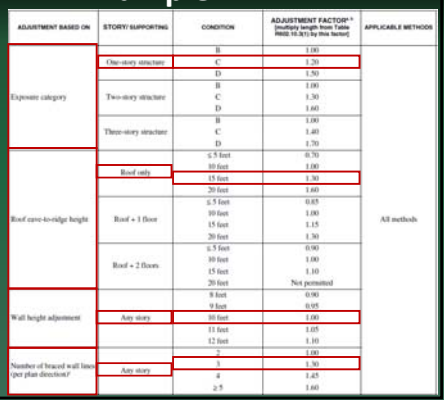
Basic Wind Speed (mph)	Story Location	Braced Wall Line Spacing (feet)	Method LIB*	Method GB	Methods DWB, WSP, SFB, PBS, PCP, HPS, CS-SFB*	Methods CS-WSP, CS-G, CS-PF
≤ 100		10	4.5	4.5	5.0	2.5
		20	8.5	8.5	9.0	4.0
		30	12.0	12.0	7.0	6.0
		40	15.5	15.5	9.0	7.5
		50	19.0	19.0	11.0	9.5
		60	22.5	22.5	13.0	11.0
		10	8.5	8.5	5.0	4.5
		20	16.0	16.0	9.0	8.0
		30	23.0	23.0	13.0	11.0
		40	29.5	29.5	17.0	14.5
		50	36.5	36.5	21.0	18.0
		60	43.5	43.5	25.0	21.0
		10	NP	12.5	7.5	6.0
		20	NP	23.5	13.5	11.5
		30	NP	34.0	19.5	16.5
		40	NP	44.0	25.0	21.5
		50	NP	54.0	31.0	26.5
		60	NP	64.0	36.5	31.0

80

Example

3) Adjust it!

- 1.2
- 1.3
- 1.0
- 1.3



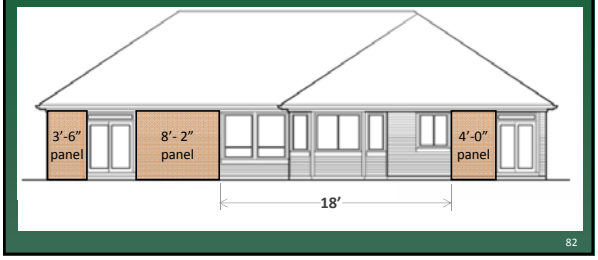
ADJUSTMENT BASED ON	STORY/ SUPPORTING	CONDITION	ADJUSTMENT FACTOR* [multiply length from Table R602.10.3(1) by this factor]	APPLICABLE METHODS
Exposure category		B	1.00	All methods
	One-story structure	C	1.20	
		D	1.30	
	Two-story structure	B	1.00	
		C	1.30	
		D	1.60	
	Three-story structure	B	1.00	
		C	1.40	
		D	1.70	
Roof eave-to-ridge height	Roof only	≤ 5 feet	0.70	
		10 feet	1.00	
		15 feet	1.30	
		20 feet	1.60	
	Roof + 1 floor	≤ 5 feet	0.85	
		10 feet	1.00	
		15 feet	1.15	
		20 feet	1.30	
	Roof + 2 floors	≤ 5 feet	0.90	
		10 feet	1.00	
		15 feet	1.10	
		20 feet	Not permitted	
Wall height adjustment	Any story	9 feet	0.90	
		9 feet	0.95	
		10 feet	1.00	
		11 feet	1.05	
		12 feet	1.10	
Number of braced wall lines (per plan direction)†	Any story	2	1.00	
		3	1.30	
		4	1.45	
		≥ 5	1.60	

Example

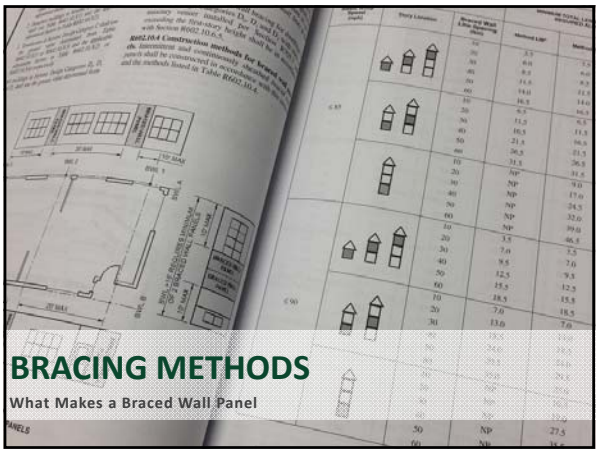
4) Compare it! Adjusted length to cumulative length:

Adjusted length $7 \times 1.2 \times 1.3 \times 1.0 \times 1.3$ 14.2’

Cumulative length $3.5 + 8.167 + 4$ 15.67’ > 14.2’ OK!



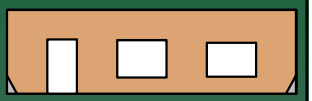
82



Engineered Bracing Types

- Segmented shear walls
  - Separate shear walls
  - Hold down at each end

- Perforated shear walls
  - One large shear wall
  - Hold down at each end
  - Openings permitted



R602.10.4 95

Prescriptive Bracing Types

- Intermittent bracing
  - Equivalent to segmented shear walls
  - Sheath at BWP locations only

- Continuous sheathing
  - Equivalent to perforated shear walls
  - Sheath all exposed areas

R602.10.4 96

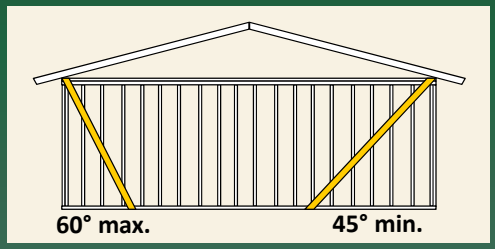
Intermittent Bracing Methods

- LIB: let in bracing
- WSP: wood structural panels
- SFB: structural fiberboard
- GB: gypsum board
- PFH: portal frame with hold downs
- PFG: portal frame at garages

R602.10.4 97

LIB: Let-in Bracing

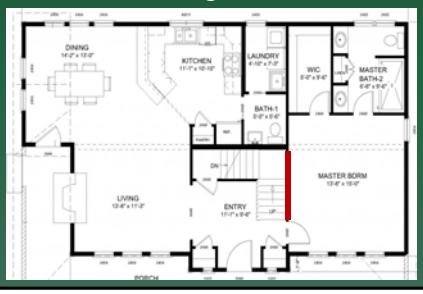
- 1x4 wood or metal strap
- 45° to 60° angle
- 2 8d nails per stud



R602.10.4 98

LIB: Let-in Bracing

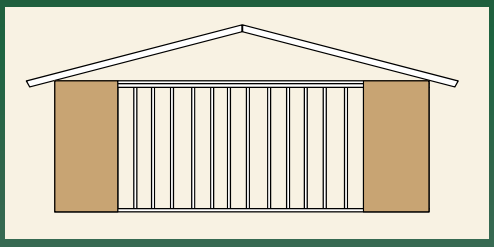
TIP: Place LIB bracing in an interior wall that does not have full height gypsum board is an easy way to provide "hidden" bracing.



99

WSP: Wood Structural Panels

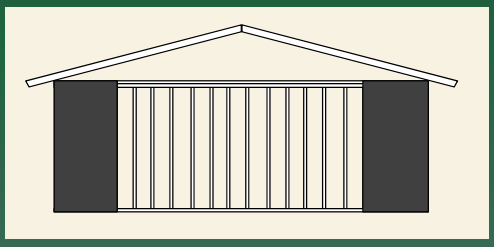
- $^{7}/_{16}$ thick OSB or plywood
- Fasteners: 6d nails @ 6” o.c. edges, 12” o.c. field
- 48” minimum length



R602.10.4 100

SFB: Structural Fiberboard

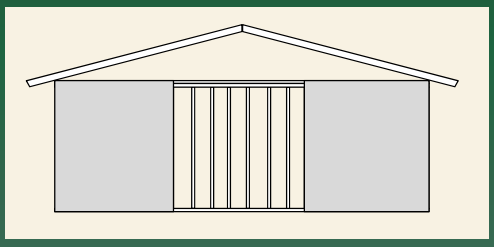
- $^{1}/_{2}$ thick @ 16” o.c. stud spacing only
- Fasteners: 8d nails @ 3” o.c. edges, 6” o.c. field
- 48” minimum length



R602.10.4 101

GB: Gypsum Board

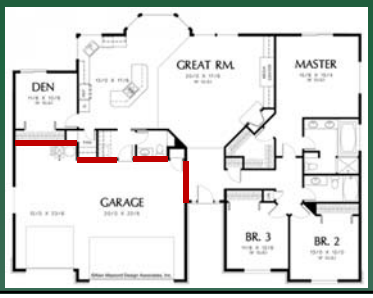
- $^{1}/_{2}$ thick
- Fasteners: nails or screws @ 7” o.c. edges and field
- 48” minimum length



R602.10.4 102

GB: Gypsum Board

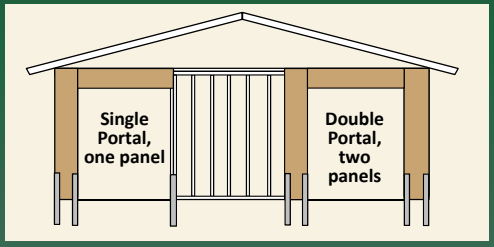
TIP: The fire separation between the garage and living space is an efficient way to get added bracing.



103

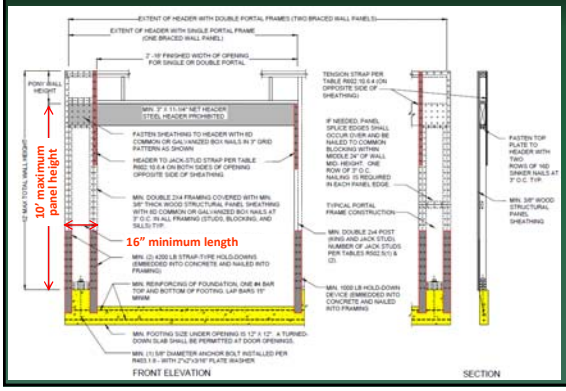
PFH: Portal Frame with Hold-down

- $^{7}/_{16}$ thick OSB or plywood
- Cast in place hold downs required



R602.10.6.2 104

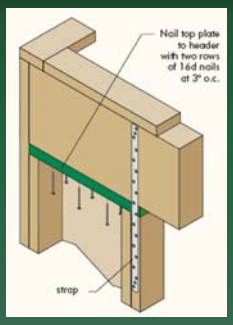
PFH: Portal Frame with Hold-down



105

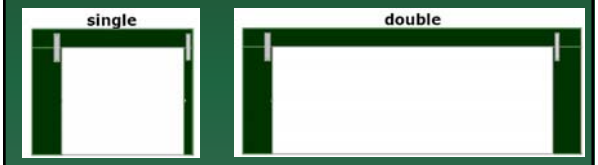
TIP: Portal Frames

- Tested assembly
- Cannot be engineered
- Field deviations prohibited



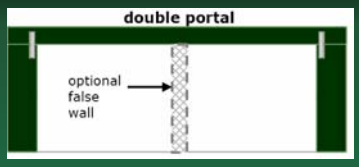
R602.10.6.2

TIP: Portal Frames at Garages



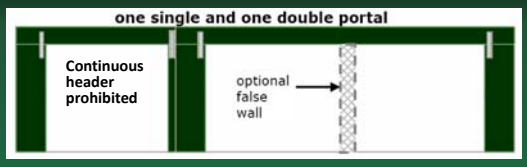
One Opening

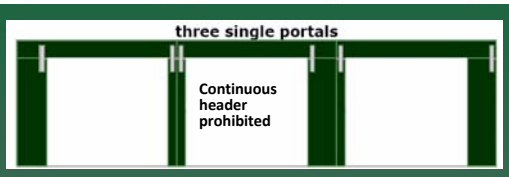
TIP: Portal Frames at Garages



Two Openings

TIP: Portal Frames at Garages

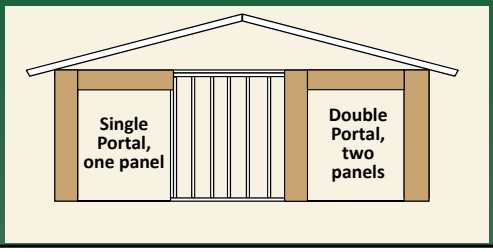




Three Openings

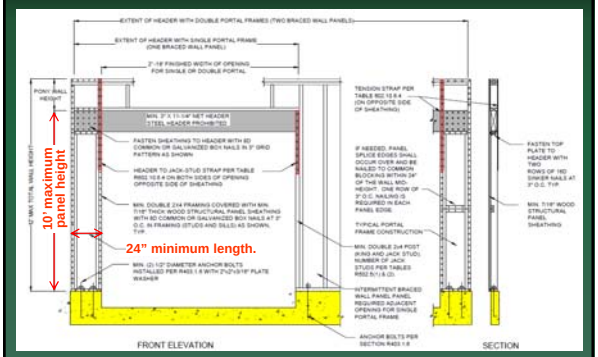
PFG: Portal Frame at Garage Opening

- $^{7}/_{16}$ thick OSB or plywood
- At garage only
- No hold downs



R602.10.6.3

PFG: Portal Frame at Garage Opening



Equivalent Products

- Equivalent to BWP
- Per ICC ES Evaluation Report
- Simpson Strong Tie:
  - Steel Strong Wall
  - Wood Strong Wall
  - SB Shearwall
- Hardy HFX Series Panels

114

Equivalent Products

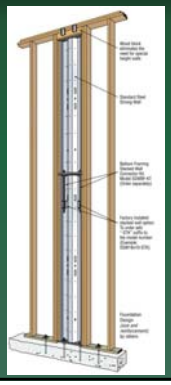



Product	Manufacturer	Minimum Available Width	ICC ES ESR Number
Steel Strong Walls	Simpson Strong-Tie	12"	1679
Wood Strong Walls	Simpson Strong-Tie	16"	1267
SB Shearwalls	Simpson Strong-Tie	12"	2652
HFX Panels	Hardy Frame	9" (nailer not included)	2089

115

Two-Story Walls

TIP: Some approved equivalent products can be stacked to brace two story, balloon framed walls.



116

Continuous Sheathing Bracing Methods

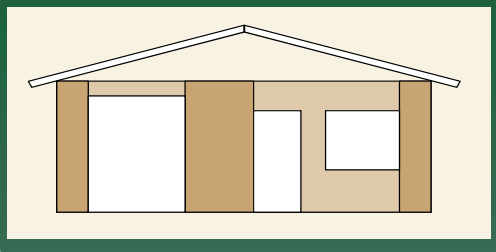
- CS WSP: wood structural panels
- CS SFB: structural fiberboard
- CS G: wood structural panels adjacent garage openings
- CS PF: continuous sheathing portal frame

R602.10.4

117

CS-WSP: Wood Structural Panels

- $^{7}/_{16}$ thick OSB or plywood
- Fasteners: 6d nails @ 6" o.c. edges, 12" o.c. field
- 24" minimum length

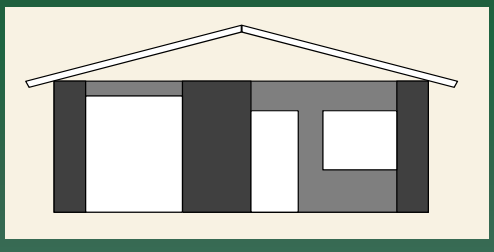


R602.10.4

118

CS-SFB: Structural Fiberboard

- $^{1}/_{2}$ thick structural fiberboard
- Fasteners: 8d nails @ 3" o.c. edges, 6" o.c. field
- 24" minimum length

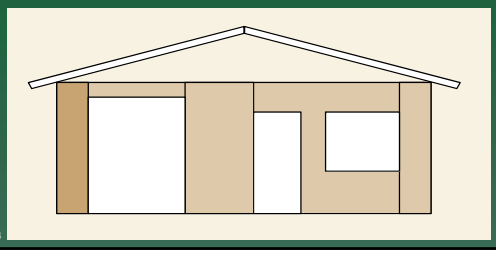


R602.10.4

119

CS G: Wood Structural Panels at Garage

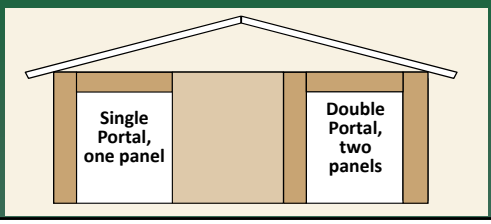
- $^{7}/_{16}$ thick OSB or plywood
- Fasteners: 6d nails @ 6” o.c. edges, 12” o.c. field
- 24” minimum length; one opening only
- No floors above



R602.10.4 120

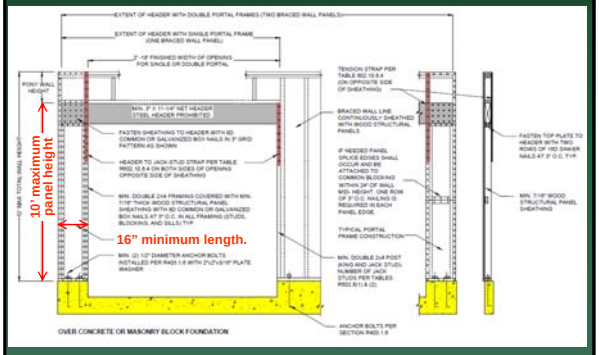
CS PF: Continuous Sheathing Portal Frame

- $^{7}/_{16}$ thick OSB or plywood
- No hold downs
- Can be constructed on wood floor
- 4 panels maximum in one BWL



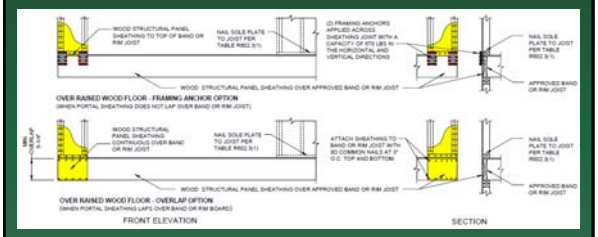
R602.10.6.3.4 121

CS PF: Continuous Sheathing Portal Frame



122

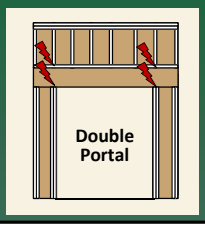
CS PF: Continuous Sheathing Portal Frame

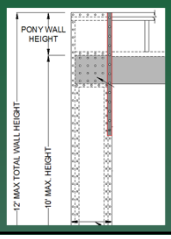


123

Pony Walls on Portal Frames

- Creates hinges
- Strap resists hinge forces
- Table R602.10.6.4 determines strap capacity



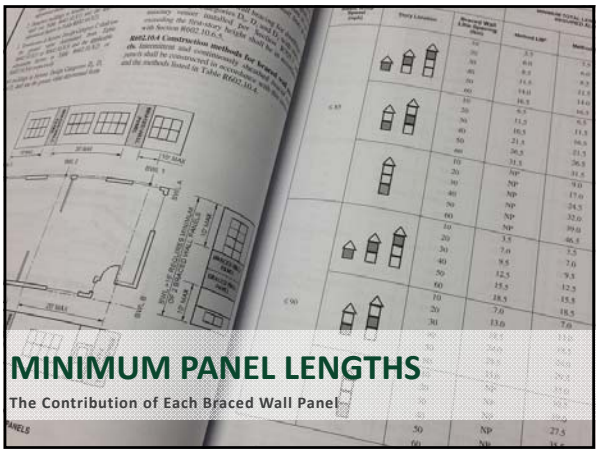


R602.10.6.4 124

Pony Walls on Portal Frames

MINIMUM WALL STUD FRAMING NOMINAL SIZE AND GRADE	MAXIMUM PONY WALL HEIGHT (feet)	MAXIMUM TOTAL WALL HEIGHT (feet)	MAXIMUM OPENING WIDTH (feet)	TENSION STRAP CAPACITY REQUIRED (pounds)[a, b]					
				Basic Wind Speed (mph)					
				85	90	100	85	90	100
				Exposure B			Exposure C		
2 × 4 No. 2 Grade	0	10	18	1,000	1,000	1,000	1,000	1,000	1,000
	1	10	9	1,000	1,000	1,000	1,000	1,000	1,275
			16	1,000	1,000	1,750	1,800	2,325	3,500
			18	1,000	1,200	2,100	2,175	2,725	DR
	2	10	9	1,000	1,000	1,025	1,075	1,550	2,500
			16	1,525	2,025	3,125	3,200	3,900	DR
			18	1,875	2,400	3,575	3,700	DR	DR
	2	12	9	1,000	1,200	2,075	2,125	2,750	4,000
			16	2,600	3,200	DR	DR	DR	DR
			18	3,175	3,900	DR	DR	DR	DR
	4	12	9	1,775	2,350	3,500	3,550	DR	DR
			16	4,175	DR	DR	DR	DR	DR

Tab e R602.10.6.4 125

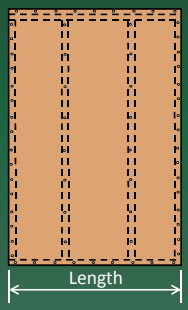


MINIMUM PANEL LENGTHS

The Contribution of Each Braced Wall Panel

BWP Minimum Length

DEFINITION: The dimension required for a length of sheathed wall to be considered a braced wall panel which contributes to the MWFRS.



R602.10.5

131

Minimum Length of Intermittent BWPs

- Known values:
  - Method
  - Wall height
- LIB minimum length based on 60° angle

METHOD (See Table R602.10.4)	MINIMUM LENGTH[a] (inches)				
	Wall Height				
	8 feet	9 feet	10 feet	11 feet	12 feet
DWB, WSP, SFB, PBS, PCP, HPS, BV-WSP	48	48	48	53	58
GB	48	48	48	53	58
LIB	55	62	69	NP	NP

Tab e R602.10.5

132

Minimum Length of Narrow Methods

- Known values:
  - Method
  - Wall height
- Method PFH requires stories above

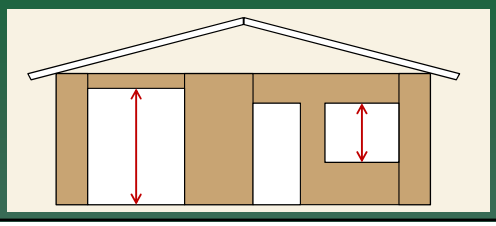
METHOD (See Table R602.10.4)		MINIMUM LENGTH[a] (inches)				
		Wall Height				
		8 feet	9 feet	10 feet	11 feet	12 feet
PFH	Supporting roof only	16	16	16	18[c]	20[c]
	Supporting one story and roof	24	24	24	27[c]	29[c]
PFG		24	27	30	33[d]	36[d]
CS-G		24	27	30	33	36
CS-PF		16	18	20	22[c]	24[c]

Tab e R602.10.5

133

Minimum Length of CS-WSP, CS-SFB

- Based on height of adjacent opening(s)
- Where opening on both sides, use taller



134

Minimum Length of Continuous Sheathing

Adjacent clear opening height (inches)	8 feet	9 feet	10 feet	11 feet	12 feet
≤ 64	24	27	30	33	36
68	26	27	30	33	36
72	27	27	30	33	36
76	30	29	30	33	36
80	32	30	30	33	36
84	35	32	32	33	36
88	38	35	33	33	36
92	43	37	35	35	36
96	48	41	38	36	36
100	—	44	40	38	38
104	—	49	43	40	39
108	—	54	46	43	41
112	—	—	50	45	43
116	—	—	55	48	45
120	—	—	60	52	48
124	—	—	—	56	51
128	—	—	—	61	54
132	—	—	—	66	58
136	—	—	—	—	62
140	—	—	—	—	66
144	—	—	—	—	72

27" minimum

Tab e R602.10.5

135

Minimum Length of Continuous Sheathing

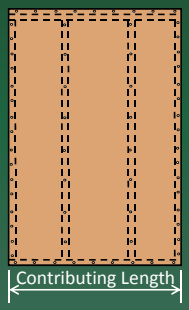
Adjacent clear opening height (inches)	8 feet	9 feet	10 feet	11 feet	12 feet
≤ 64	24	27	30	33	36
68	26	27	30	33	36
72	27	27	30	33	36
76	30	29	30	33	36
80	32	30	30	33	36
84	35	32	32	33	36
88	38	35	33	33	36
92	43	37	35	35	36
96	48	41	38	36	36
100	—	44	40	38	38
104	—	49	43	40	39
108	—	54	46	43	41
112	—	—	50	45	43
116	—	—	55	48	45
120	—	—	60	52	48
124	—	—	—	56	51
128	—	—	—	61	54
132	—	—	—	66	58
136	—	—	—	—	62
140	—	—	—	—	66
144	—	—	—	—	72

30" minimum

Tab e R602.10.5

BWP Contributing Length

DEFINITION: The dimension a BWP contributes towards a BWL's required length of bracing.



R602.10.5.1

BWP Contributing Length

- Use Table R602.10.5
- Based on method
- Equivalent products 48"

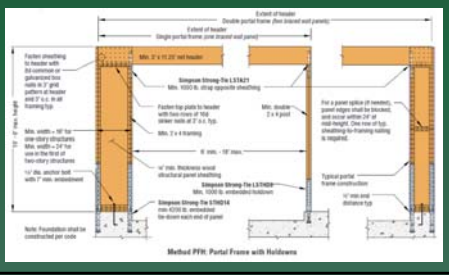
METHOD (See Table R602.10.4)		MINIMUM LENGTH[a] (inches) Wall Height 8 feet	9 feet	10 feet	11 feet	12 feet	CONTRIBUTING LENGTH (inches)
DWB, WSP, SFB, PBS, PCP, HPS, BV-WSP		48	48	48	53	58	Actual[b]
GB		48	48	48	53	58	Double sided = Actual Single sided = 0.5 × Actual
LIB		55	62	69	NP	NP	Actual[b]
ABW	SDC A, B and C, wind speed < 110 mph	28	32	34	38	42	48
	SDC D_0, D_1 and D_2, wind speed < 110 mph	32	32	34	NP	NP	
PFH	Supporting roof only	16	16	16	18[c]	20[c]	48
	Supporting one story and roof	24	24	24	27[c]	29[c]	48
PFG		24	27	30	33[c]	36[c]	1.5 × Actual[b]
CS-G		24	27	30	33	36	Actual[b]
CS-PF		16	18	20	22[c]	24[c]	1.5 × Actual[b]

Tab e R602.10.5

*Virginia 2012, IRC 2015

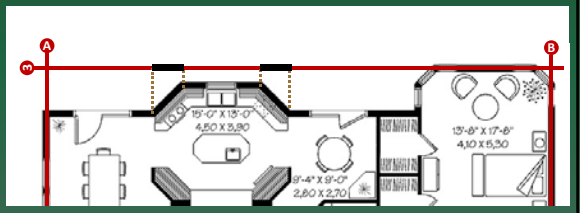
BWP Contributing Length

TIP: Narrow methods PFH, PFG, CS PF and equivalent products are a way to provide more bracing than the actual wall length.



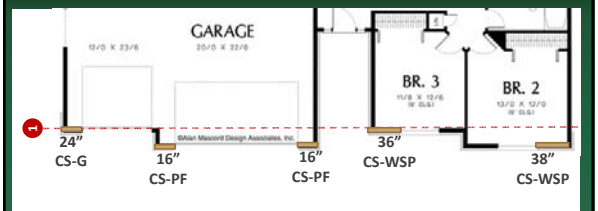
BWP Projected Length

- Angled BWPs contribute projected length only
- Can project to one BWL only



R602.10.3

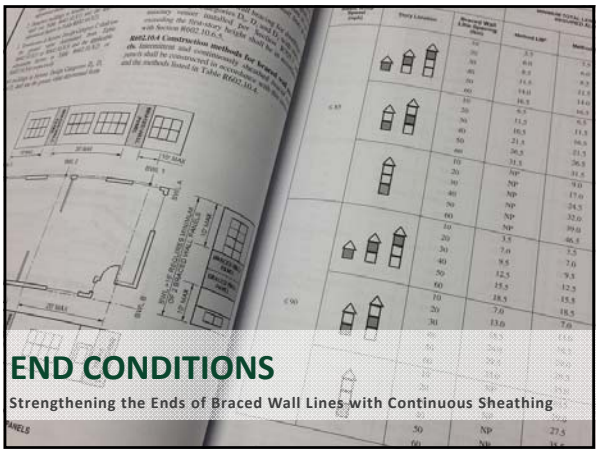
BWP Contributing Length



The cumulative length of all BWPs in BWL 1 =

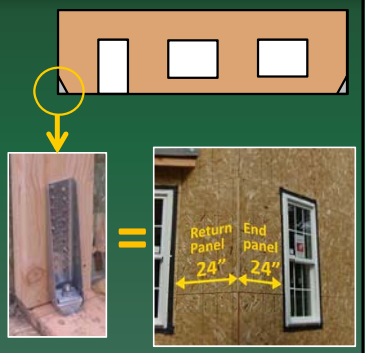
24 + (16 x 1.5) + (16 x 1.5) + 36 + 38 = 146" = 12'-2"

R602.10.5.1



End Conditions

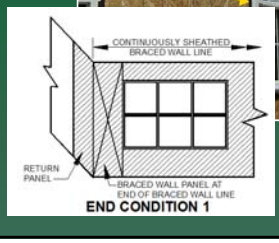
- Perforated shear walls: hold downs at each end
- Continuous sheathing: 24" panels each side of corner



R602.10.7 150

End Conditions

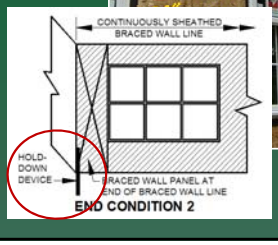
- End panel BWP since…
  - ≤ 64" opening
  - 8' tall wall
  - BWP 24" panel length
- Return panel
- End Condition 1



R602.10.7 151

End Conditions

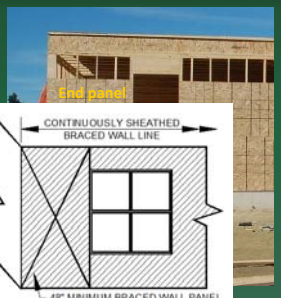
- End panel BWP
- No return panel
- End Condition 2
- Add 800 lbs. hold down device



R602.10.7 152

End Conditions

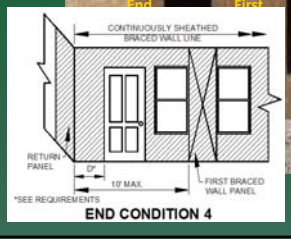
- 48" sheathing at end also equivalent to hold down device
- End panel BWP
- No return panel or hold down
- End Condition 3



R602.10.7 153

End Conditions

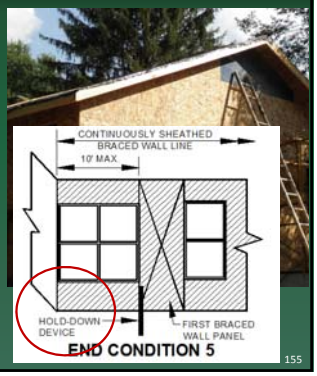
- End panel ≠ BWP
- End panel 24"
- Return panel
- First BWP begins ≤ 10' from end
- End Condition 4



R602.10.7 154

End Conditions

- No end panel
- No return panel
- First BWP begins ≤ 10’ from end
- End Condition 5
- Add 800 lbs. hold down device

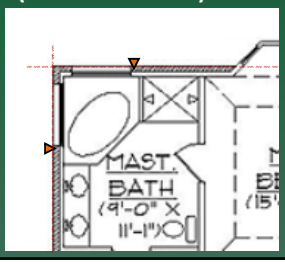


R602.10.7

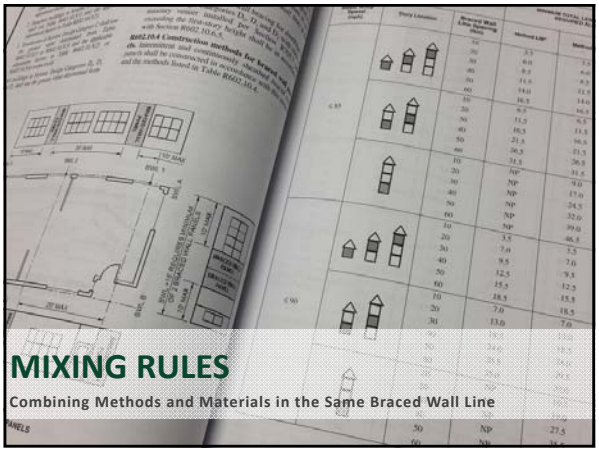
155

End Conditions

TIP: Where 2 BWLs with continuous sheathing meet at a corner and one side requires a hold down, the opposite side will usually require a hold down or 48” end panel (End Condition 3).



156



MIXING RULES

Combining Methods and Materials in the Same Braced Wall Line

Mixing Methods Rule 1

- Mixing methods from BWL to BWL is permitted

BWL must include return panels, if applicable

R602.10.4

161

Mixing Methods Rule 2

- Mixing intermittent methods along a BWL is permitted

BWL must be designed for weakest method

R602.10.4

162

Mixing Methods Rule 3

- Any narrow method can mix with CS WSP
- No other methods can mix with CS SFB

NO mixing in CS-SFB

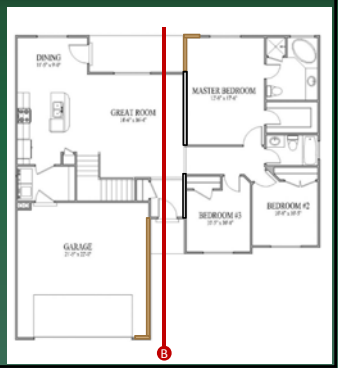
ABW, PFH, PFG, CS-PF permitted in CS-WSP

R602.10.4

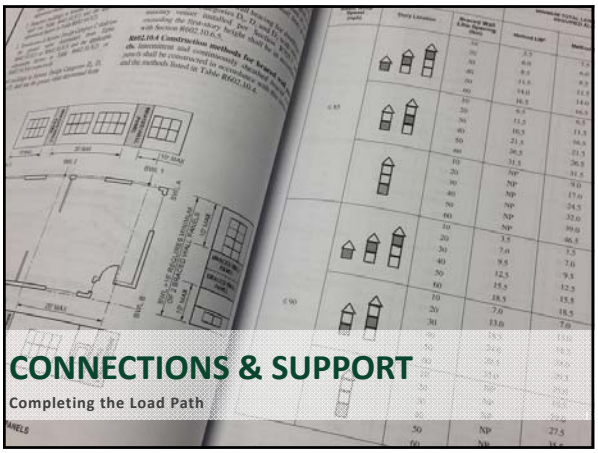
163

Mixing Methods Rule 4

- Mixing intermittent and continuous sheathing is permitted
  - CS on exterior
  - Intermittent on interior
  - Design for weakest methods
- Be alert for end condition requirements



R602.10.4

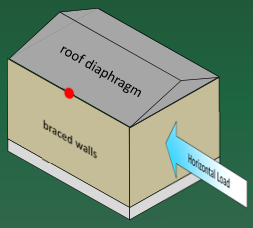


CONNECTIONS & SUPPORT

Completing the Load Path

Completing the Load Path: Roof

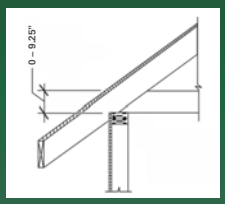
- Roof diaphragm to BWPs



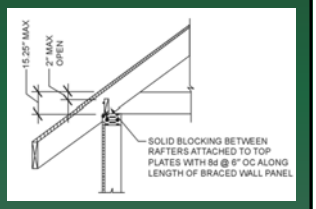
R602.10.8.1 168

Completing the Load Path: Roof

- Roof diaphragm to BWPs



≤ 9.25"
No blocking required

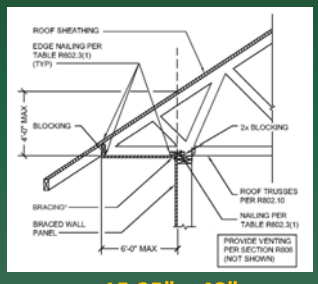


> 9.25" – 15.25"
2x blocking

R602.10.8.1 169

Completing the Load Path: Roof

- Roof diaphragm to BWPs

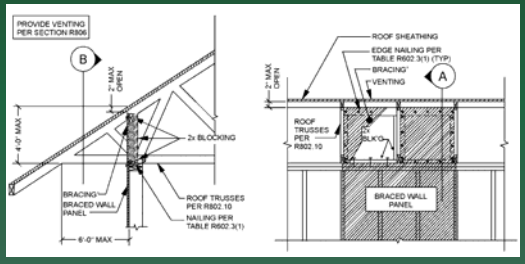


15.25" – 48"
Soffit panel or…

R602.10.8.1 170

Completing the Load Path: Roof

- Roof diaphragm to BWPs

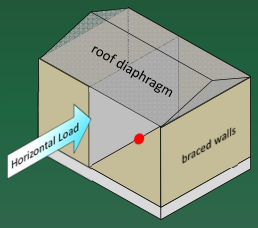


15.25" – 48"
Vertical blocking panel

R602.10.8.1 171

Completing the Load Path: Interior BWPs

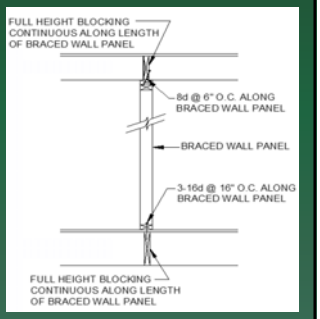
- Interior BWPs to floors



R602.10.8.1 172

Completing the Load Path: Interior BWPs

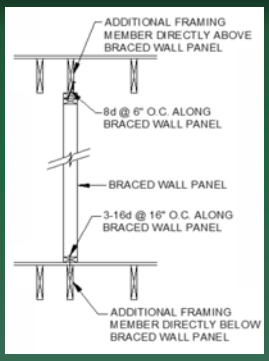
- Interior BWPs to floors
- Where joists are perpendicular:
  - Full height blocking
  - Between joists
  - Full length of BWP



R602.10.8 173

Completing the Load Path: Interior BWPs

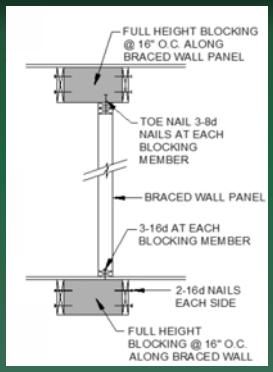
- Where joists are parallel:
  - Option 1: provide additional joists



R602.10.8 174

Completing the Load Path: Interior BWPs

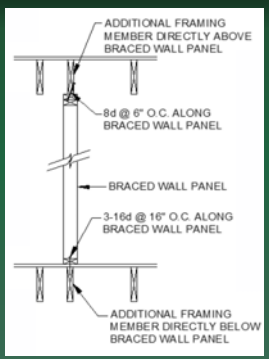
- Where joists are parallel:
  - Option 1: provide additional joists
  - Option 2: provide additional blocking
    - Perpendicular @ 16" o.c.
    - Full length of BWP



R602.10.8 175

Completing the Load Path: Interior BWPs

TIP: Placing an interior BWP within a bearing wall will eliminate the need for added blocking.



R602.10.8 176

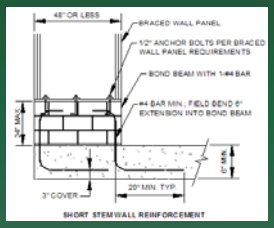
Completing the Load Path: Stem Walls

- Masonry or concrete
- BWPs to stem walls
- Reinforce stem walls
  - < 48" long BWPs
  - Stem walls up to 48" high
  - Stem walls > 48" high require RDP design

R602.10.9 177

Completing the Load Path: Stem Walls

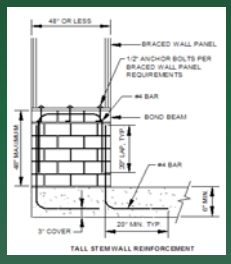
- Stem wall height ≤ 24”
- Cast in place #4 dowels
- Bend dowels into bond beam



R602.10.9 178

Completing the Load Path: Stem Walls

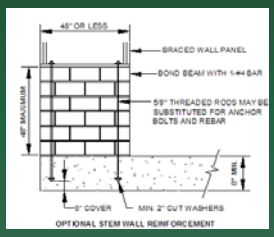
- Stem wall up to 48” high
- Cast in place #4 dowels
- Additional “hair pin” #4 rebar lapped to dowels



R602.10.9 179

Completing the Load Path: Stem Walls

- Non rebar option
- Stem wall up to 48” high
- Cast in place $^{5}/_{8}$ threaded rod
- Epoxy option with 5,000 lbs. pull out value (V rg nia amendment)
- 2” cut washers



R602.10.9 180

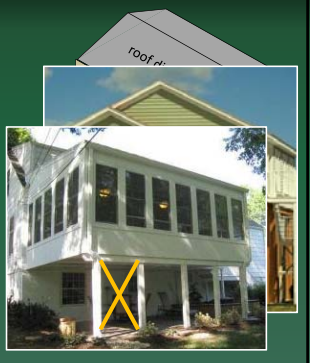
Completing the Load Path: Cantilevers

- Short cantilevered diaphragms can transfer load to BWPs
- Cantilevers per R502.3.3 permissible

R602.10.9 181

Completing the Load Path: Piers

- Walls above piers per R602.10
- Piers by RDP
- Common error: sunrooms on posts
- Common solution: cross bracing



R602.10.9 182

"Practical" Wall Bracing

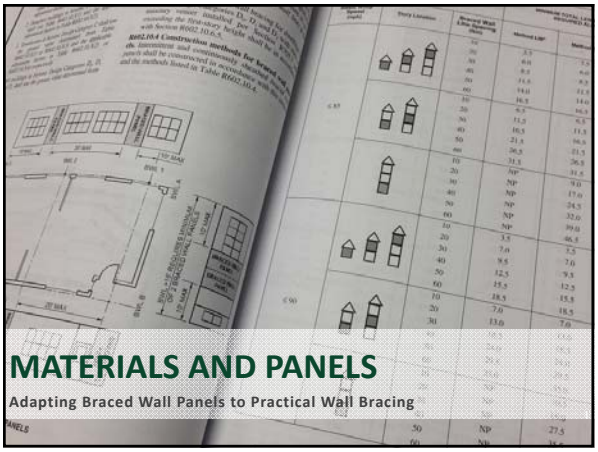
- Virginia only
- Simpler alternative to classic" wall bracing
- *Braced wall panels* (BWP)
- *Circumscribed rectangles*
- Based on "Simplified Wall Bracing from IRC

R602.12 3

Where Applicable

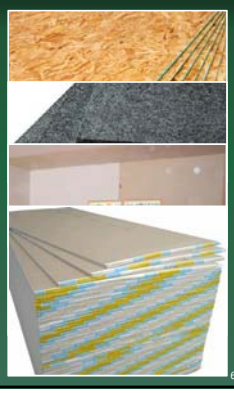
- In SDC A & B
- Detached houses in SDC C
- Cannot mix classic" with "practical"

R602.12 4



Sheathing Materials

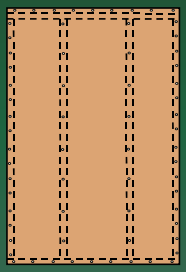
- Exterior
  - $^{7}/_{16}$" OSB or plywood (fasten 6" edge, 12" field)
  - $^{1}/_{2}$" structural fiberboard (fasten 3" edge, 6" field)
  - Sheath entire exterior (continuous sheathing)
  - Cannot mix materials
- Interior: $^{1}/_{2}$ gypsum board (fasten 7" edge, field)



R602.12.1 6

Braced Wall Panel

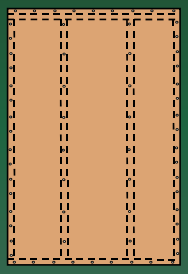
- Same as classic"
  - Full height
  - No offsets
  - Splices permitted
- Minimum Length:
  - Interior: 48"
  - Exterior, per Table R602.12.2
- "Classic" carryovers:
  - Narrow methods: ABW, PFH, PFG, CS PF



R602.10.2 7

Braced Wall Panel

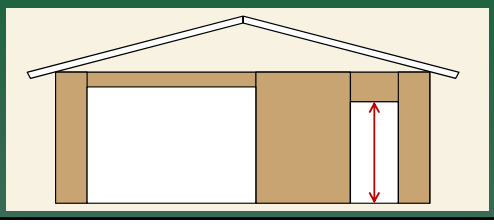
- Contributing Length
  - Exterior actual
  - Interior 0.5 x actual
  - "Classic" narrow methods:
    - PFH 48"
    - PFG, CS PF 1.5 x actual
    - Equivalent products 48"



R602.10.2 8

Exterior BWP Minimum Length

- Based on adjacent opening(s)
  - Adjacent garage opening or
  - Height of adjacent opening



9

Exterior BWP Minimum Length

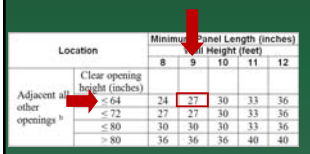
TABLE R602.12.2
BRACED WALL PANEL LENGTHS

Location		Minimum Panel Length (inches) Wall Height (feet) 8	9	10	11	12
Adjacent garage door of one-story garage[a]		24	27	30	33	36
Adjacent all other openings[b]	Clear opening height (inches) ≤ 64	24	27	30	33	36
	≤ 72	27	27	30	33	36
	≤ 80	30	30	30	33	36
	> 80	36	36	36	40	40

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm
a. Braced wall panels supporting a gable end wall or roof load only.
b. Interpolation shall be permitted.

R602.12.2 10

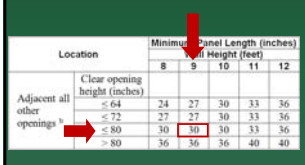
Exterior BWP Minimum Length



27" minimum

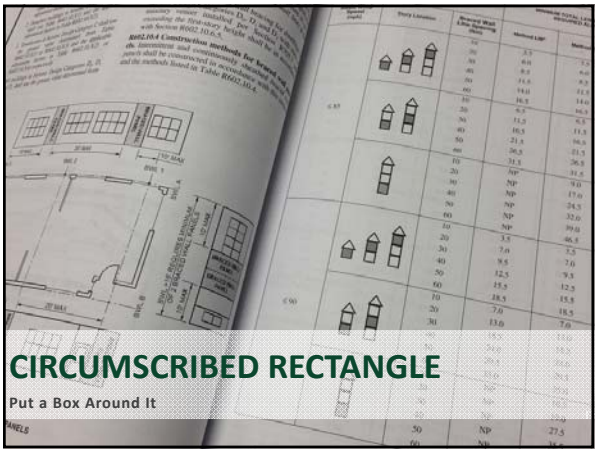
Tab e R602.10.5 11

Exterior BWP Minimum Length



30" minimum

Tab e R602.10.5 12



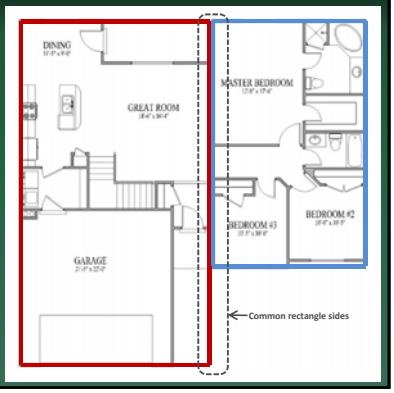
Circumscribed Rectangle

DEFINITION: A rectangle that surrounds a building or portions thereof with a minimum length of bracing assigned to each side.

R602.12.3

Circumscribed Rectangles

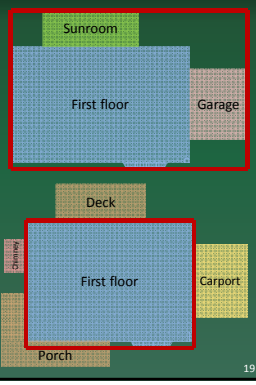
- Unlimited rectangles permitted
- Identify common rectangle sides



R602.10.1.1

Circumscribed Rectangles

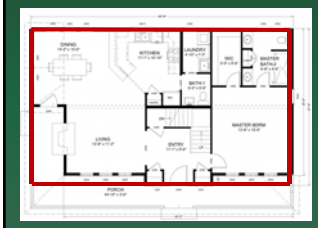
- Include enclosed offsets and projections
  - Sunrooms
  - Garages
  - Bay windows
- Exclude open structures
  - Decks
  - Carports
  - Screened porches
- Exclude chimneys



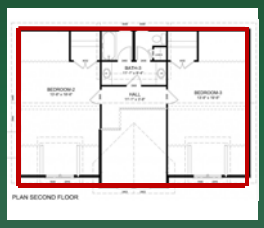
R602.12.3 19

Circumscribed Rectangles

- Different rectangle(s) for each floor



First Floor

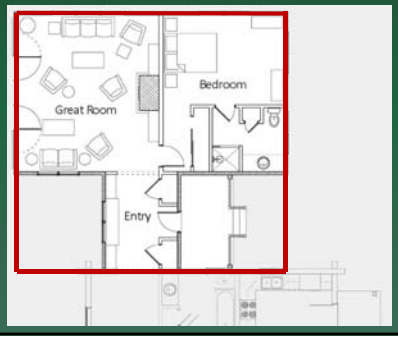


Second Floor

R602.12.3 20

Circumscribed Rectangles

- Can be applied to additions



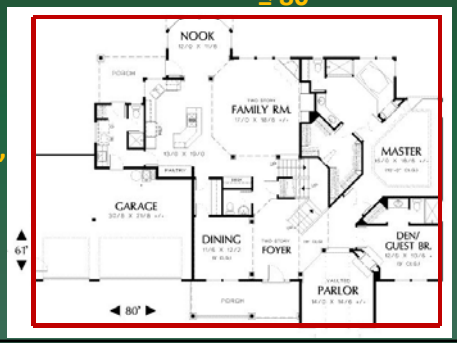
R602.12.3 21

Circumscribed Rectangles

- Maximum size: 80’ x 80’

≤ 80’

≤ 80’



R602.12.3 22

Circumscribed Rectangles

- Maximum aspect ratio: $\frac{\text{long side}}{\text{short side}}$ 3:1

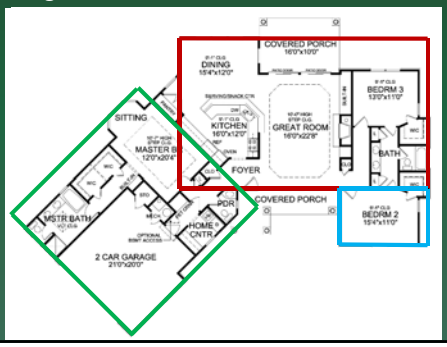
3

1

R602.12.3 23

Circumscribed Rectangles

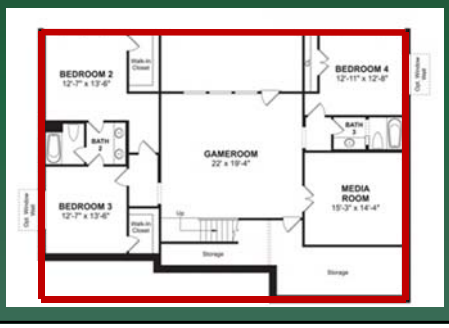
- Rectangles can be skewed



R602.12.3 24

Circumscribed Rectangles

- Applies to walk out conditions

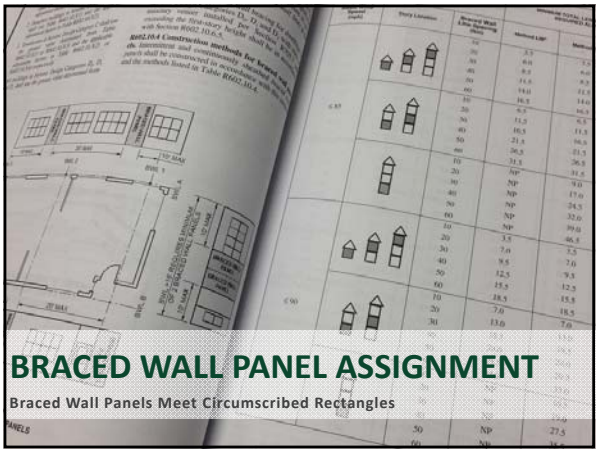


R602.12.3 25

Circumscribed Rectangles

TIP: One rectangle relies solely on exterior bracing. Multiple rectangles results in complicated interiors. Deciding the most efficient number of rectangle may be an iterative process.

26



BRACED WALL PANEL ASSIGNMENT

Braced Wall Panels Meet Circumscribed Rectangles

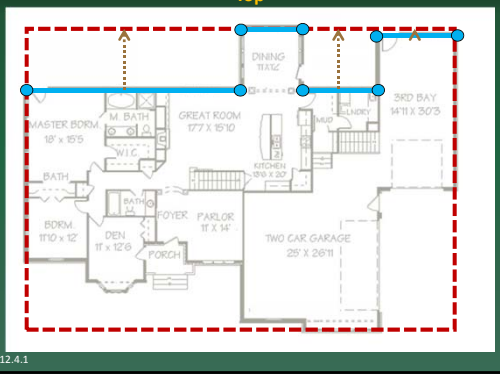
BWP Assignment Rules

- Exterior BWPs
  - Located on rectangle side
  - Facing rectangle side
- Interior BWPs
  - Located on rectangle side
  - Facing within 4 feet of interior rectangle side
- Angled BWPs
  - Projections to each adjacent rectangle side

R602.12.4.1 33

Exterior BWPs on or Facing Rectangle Side

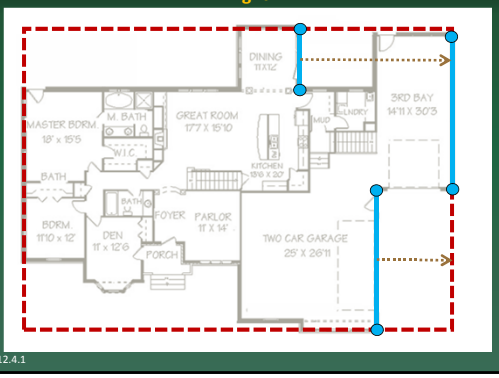
Top



R602.12.4.1 34

Exterior BWPs on or Facing Rectangle Side

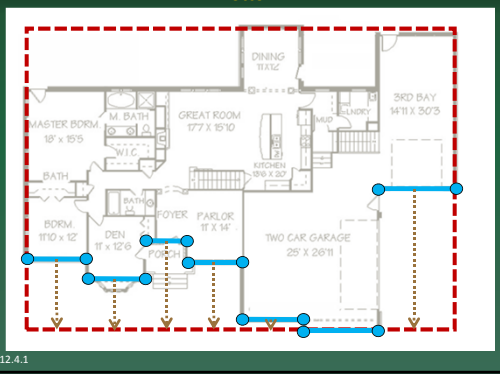
Right



R602.12.4.1 35

Exterior BWPs on or Facing Rectangle Side

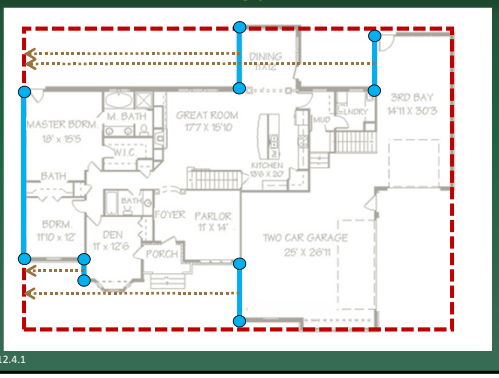
Bottom



R602.12.4.1 36

Exterior BWPs on or Facing Rectangle Side

Left

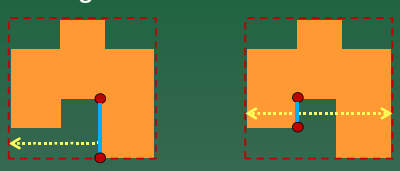


R602.12.4.1 37

Exterior BWPs on or Facing Rectangle Side

TIP 1: Assign a partially obscured BWP to the parallel rectangle side it's unobscured portion faces.

TIP 2: Assign an wholly obscured BWP to either parallel rectangle side.

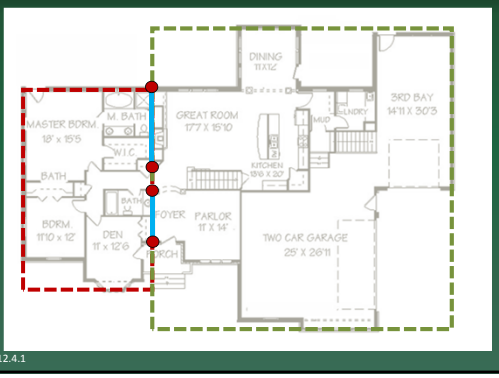


Partially Obscured

Obscured

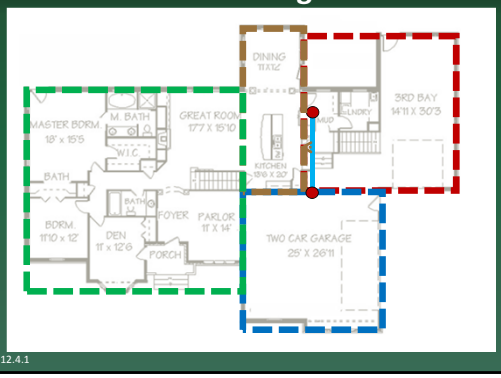
38

Interior BWP on Rectangle Side



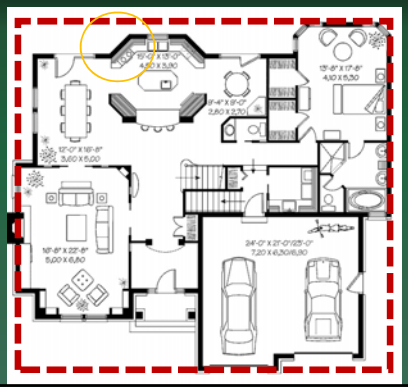
R602.12.4.1 39

Interior BWP within 4' of Parallel Rectangle Side



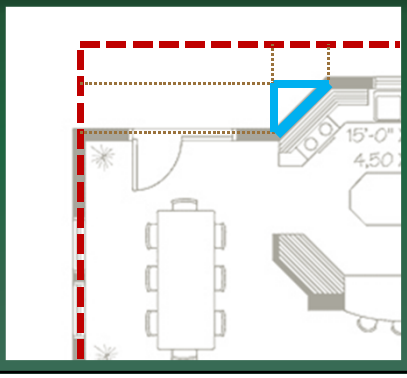
R602.12.4.1 40

Projections of Angled BWPs



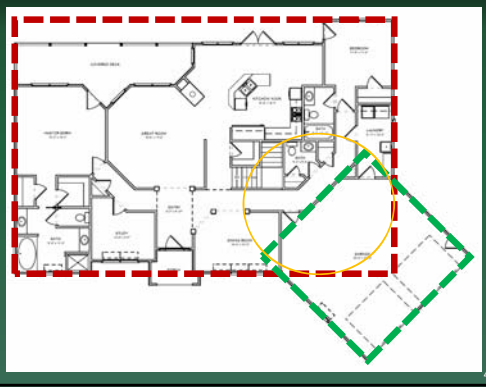
R602.12.4.1 41

Projections of Angled BWPs



R602.12.4.1 42

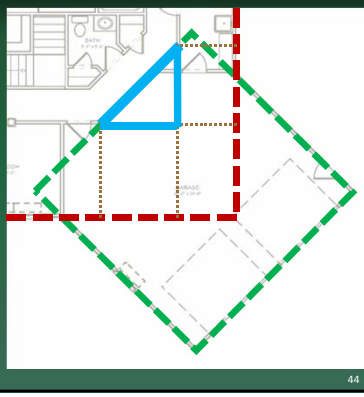
Shared BWPs at Skewed Rectangles



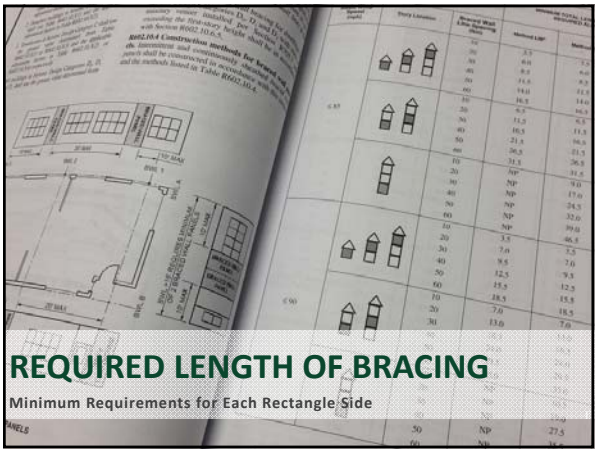
R602.12.4.3 43

Shared BWPs at Skewed Rectangles

- Apply BWP to skewed rectangle (green) it is located on
- Apply BWL projections to non skewed rectangle (red)



R602.12.4.3 44



REQUIRED LENGTH OF BRACING

Minimum Requirements for Each Rectangle Side

Cumulative Length of Rectangle Side

- Total length of BWPs assigned to a rectangle side must exceed code value
- Calculate using Tables R602.12.4
- Following these steps:
  - a) **Choose it!** Select value from table
  - b) **Adjust it!** Multiply by adjustment factors
  - c) **Compare it!** Actual length ≥ minimum length

R602.10.3 56

Choose It!

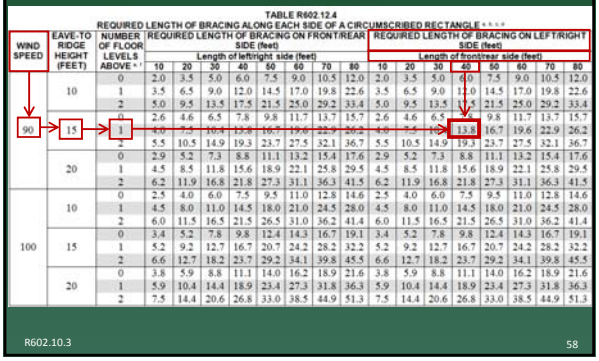
- Use Table R602.12.4
- Known values: wind speed, eave to ridge height, story location, lengths rectangle sides

TABLE R602.12.4
REQUIRED LENGTH OF BRACING ALONG EACH SIDE OF A CIRCUMSCRIBED RECTANGLE a, b, c, d

WIND SPEED	EAVE-TO RIDGE HEIGHT (FEET)	NUMBER OF FLOOR LEVELS ABOVE e, f	REQUIRED LENGTH OF BRACING ON FRONT/REAR SIDE (feet) Length of left/right side (feet) 10	20	30	40	50	60	70	80	REQUIRED LENGTH OF BRACING ON LEFT/RIGHT SIDE (feet) Length of front/rear side (feet) 10	20	30	40	50	60	70	80
90	10	0	2.0	3.5	5.0	6.0	7.5	9.0	10.5	12.0	2.0	3.5	5.0	6.0	7.5	9.0	10.5	12.0
		1	3.5	6.5	9.0	12.0	14.5	17.0	19.8	22.6	3.5	6.5	9.0	12.0	14.5	17.0	19.8	22.6
		2	5.0	9.5	13.5	17.5	21.5	25.0	29.2	33.4	5.0	9.5	13.5	17.5	21.5	25.0	29.2	33.4
	15	0	2.6	4.6	6.5	7.8	9.8	11.7	13.7	15.7	2.6	4.6	6.5	7.8	9.8	11.7	13.7	15.7
		1	4.0	7.5	10.4	13.8	16.7	19.6	22.9	26.2	4.0	7.5	10.4	13.8	16.7	19.6	22.9	26.2
		2	5.5	10.5	14.9	19.3	23.7	27.5	32.1	36.7	5.5	10.5	14.9	19.3	23.7	27.5	32.1	36.7
	20	0	2.9	5.2	7.3	8.8	11.1	13.2	15.4	17.6	2.9	5.2	7.3	8.8	11.1	13.2	15.4	17.6
		1	4.5	8.5	11.8	15.6	18.9	22.1	25.8	29.5	4.5	8.5	11.8	15.6	18.9	22.1	25.8	29.5
		2	6.2	11.9	16.8	21.8	27.3	31.1	36.3	41.5	6.2	11.9	16.8	21.8	27.3	31.1	36.3	41.5
100	10	0	2.5	4.0	6.0	7.5	9.5	11.0	12.8	14.6	2.5	4.0	6.0	7.5	9.5	11.0	12.8	14.6
		1	4.5	8.0	11.0	14.5	18.0	21.0	24.5	28.0	4.5	8.0	11.0	14.5	18.0	21.0	24.5	28.0
		2	6.0	11.5	16.5	21.5	26.5	31.0	36.2	41.4	6.0	11.5	16.5	21.5	26.5	31.0	36.2	41.4
	15	0	3.4	5.2	7.8	9.8	12.4	14.3	16.7	19.1	3.4	5.2	7.8	9.8	12.4	14.3	16.7	19.1
		1	5.2	9.2	12.7	16.7	20.7	24.2	28.2	32.2	5.2	9.2	12.7	16.7	20.7	24.2	28.2	32.2
		2	6.6	12.7	18.2	23.7	29.2	34.1	39.8	45.5	6.6	12.7	18.2	23.7	29.2	34.1	39.8	45.5
	20	0	3.8	5.9	8.8	11.1	14.0	16.2	18.9	21.6	3.8	5.9	8.8	11.1	14.0	16.2	18.9	21.6
		1	5.9	10.4	14.4	18.9	23.4	27.3	31.8	36.3	5.9	10.4	14.4	18.9	23.4	27.3	31.8	36.3
		2	7.5	14.4	20.6	26.8	33.0	38.5	44.9	51.3	7.5	14.4	20.6	26.8	33.0	38.5	44.9	51.3

R602.10.3 57

Choose It!



R602.10.3 58

Adjust It!

- Use footnotes from Table R602.12.4
- Exposure Category C
- Wall heights
- Fastener spacing

a. Interpolation shall be permitted; extrapolation shall be prohibited.
b. For Exposure Category C, multiply the required length of bracing by a factor of 1.20 for a one-story building, 1.30 for a two-story building and 1.40 for a three-story building.
c. For wall height adjustments multiply the required length of bracing by the following factors: 0.90 for 8 feet (2438 mm), 0.95 for 9 feet (2743 mm), 1.0 for 10 feet (3048 mm), 1.05 for 11 feet (3353 mm) and 1.10 for 12 feet (3658 mm).
d. Where braced wall panels supporting stories above have been sheathed in wood structural panels with edge fasteners spaced at 4 inches (102 mm) on center, multiply the required length of bracing by 0.83.
e. A floor level, habitable or otherwise, contained wholly within the roof rafters or trusses shall not be considered a floor level for purposes of determining the required length of bracing.
f. A rectangle side with differing number of floor levels above shall use the greatest number when determining the required length of bracing.

R602.12.4 59

Adjust It! - Wind Exposure

Category C

Open terrain

Grasslands, flat plains

Wind flows over open water for 1,500 feet

1.20 one-story

1.30 two-story

1.40 three-story

R602.12.4 60

Adjust It! – Wall Height

0.90 8’ wall

0.95 9’ wall

1.00 10’ wall

1.05 11’ wall

1.10 12’ wall

R602.12.4 61

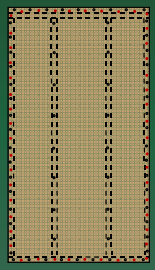
Adjust It! – No Interior Finish

1.40

R602.12.2 #4

62

Adjust It! – Fastener Spacing



4” fastener spacing

0.83

OSB or plywood (exterior) when supporting floors above

0.7

gypsum board (interior)*

*Virginia nterpretat on

R602.10.3

63

Adjust It!

- Adjusted required length of bracing the product of
  - Tabular value
  - Exposure Category C
  - Wall height
  - No interior finish
  - Fastener spacing

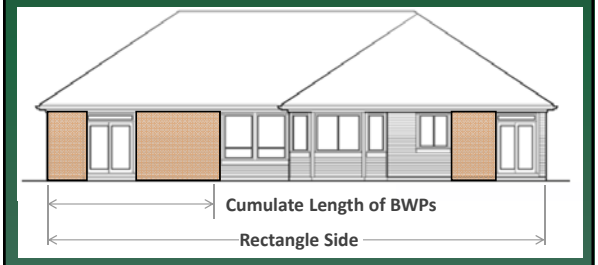
Adjusted length = (tabular value) x (adjustment factor) x (adjustment factor) x (adjustment factor)…

R602.10.3

64

Compare It!

- Cumulative length of all BWPs contributing length
- Cumulative length ≥ Adjusted length

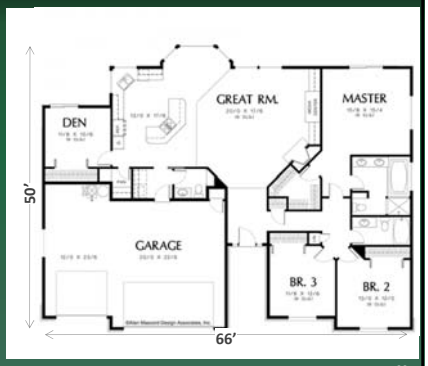


R602.10.2.2

65

Example – Does Rear Side Comply?

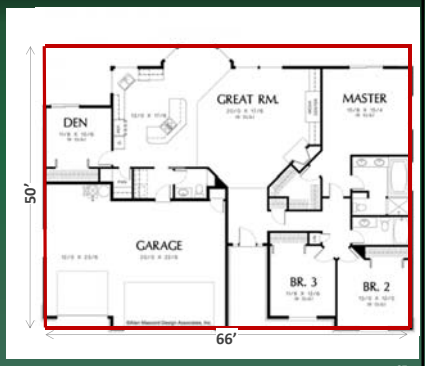
- 100 mph
- Farm house
- 15’ eave to ridge
- 10’ walls
- OSB sheathing



66

Example – Does Rear Side Comply?

1) Determine rectangle size:
66’ x 50’



67

Example

2) Choose it! Tabular value: 12.4’

TABLE R602.12.4
REQUIRED LENGTH OF BRACING ALONG EACH SIDE OF A CIRCUMSCRIBED RECTANGLE

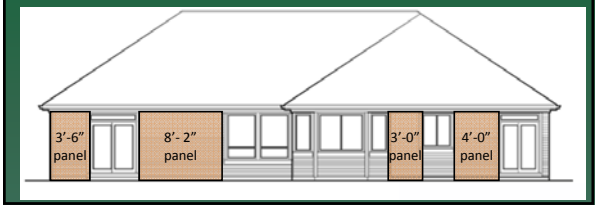
WIND SPEED	EAVE-TO RIDGE HEIGHT (FEET)	NUMBER OF FLOOR LEVELS ABOVE	REQUIRED LENGTH OF BRACING ON FRONT/REAR SIDE (feet) — Length of left/right side (feet)								REQUIRED LENGTH OF BRACING ON LEFT/RIGHT SIDE (feet) — Length of front/rear side (feet)							
			10	20	30	40	50	60	70	80	10	20	30	40	50	60	70	80
90	10	0	2.0	3.5	5.0	6.0	7.5	9.0	10.5	12.0	2.0	3.5	5.0	6.0	7.5	9.0	10.5	12.0
		1	3.5	6.5	9.0	12.0	14.5	17.0	19.8	22.6	3.5	6.5	9.0	12.0	14.5	17.0	19.8	22.6
		2	5.0	9.5	13.5	17.5	21.5	25.0	29.2	33.4	5.0	9.5	13.5	17.5	21.5	25.0	29.2	33.4
	15	0	2.6	4.6	6.5	7.8	9.8	11.7	13.7	15.7	2.6	4.6	6.5	7.8	9.8	11.7	13.7	15.7
		1	4.0	7.5	10.4	13.8	16.7	19.6	22.9	26.2	4.0	7.5	10.4	13.8	16.7	19.6	22.9	26.2
		2	5.5	10.5	14.9	19.3	23.7	27.5	32.1	36.7	5.5	10.5	14.9	19.3	23.7	27.5	32.1	36.7
	20	0	2.9	5.2	7.3	8.8	11.1	13.2	15.4	17.6	2.9	5.2	7.3	8.8	11.1	13.2	15.4	17.6
		1	4.5	8.5	11.8	15.6	18.9	22.1	25.8	29.5	4.5	8.5	11.8	15.6	18.9	22.1	25.8	29.5
		2	6.2	11.9	16.8	21.8	27.3	31.1	36.3	41.5	6.2	11.9	16.8	21.8	27.3	31.1	36.3	41.5
100	10	0	2.5	4.0	6.0	7.5	9.5	11.0	12.8	14.6	2.5	4.0	6.0	7.5	9.5	11.0	12.8	14.6
		1	4.5	8.0	11.0	14.5	18.0	21.0	24.5	28.0	4.5	8.0	11.0	14.5	18.0	21.0	24.5	28.0
		2	6.0	11.5	16.5	21.5	26.5	31.0	36.2	41.4	6.0	11.5	16.5	21.5	26.5	31.0	36.2	41.4
	15	0	3.4	5.2	7.8	9.8	12.4	14.3	16.7	19.1	3.4	5.2	7.8	9.8	12.4	14.3	16.7	19.1
		1	5.2	9.2	12.7	16.7	20.7	24.2	28.2	32.2	5.2	9.2	12.7	16.7	20.7	24.2	28.2	32.2
		2	6.6	12.7	18.2	23.7	29.2	34.1	39.8	45.5	6.6	12.7	18.2	23.7	29.2	34.1	39.8	45.5
	20	0	3.8	5.9	8.8	11.1	14.0	16.2	18.9	21.6	3.8	5.9	8.8	11.1	14.0	16.2	18.9	21.6
		1	5.9	10.4	14.4	18.9	23.4	27.3	31.8	36.3	5.9	10.4	14.4	18.9	23.4	27.3	31.8	36.3
		2	7.5	14.4	20.6	26.8	33.0	38.5	44.9	51.3	7.5	14.4	20.6	26.8	33.0	38.5	44.9	51.3

68

Example

3) Adjust it!
- Exposure 1.2
- Wall height 1.0
- Adjusted length 12.4 x 1.2 x 1.0 14.9’

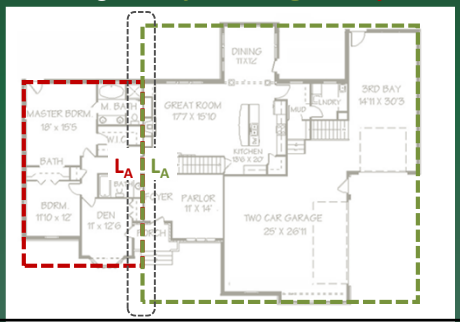
4) Compare adjusted length to cumulative length
3.5 + 8.167 + 3 + 4 15.67’ > 14.9’ OK!



BWPs on Common Rectangle Sides

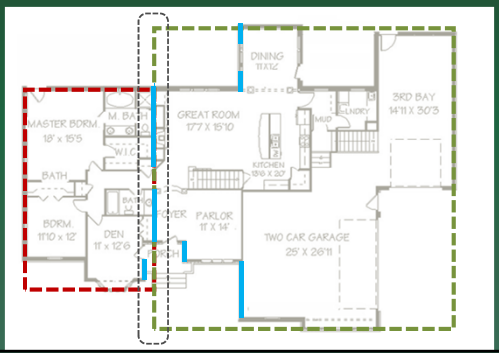
- Add for each side:

Adjusted length Adjusted length + Adjusted length

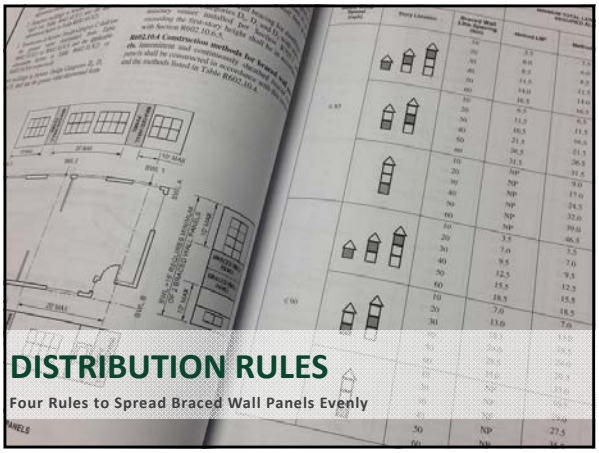


70

BWP on Common Rectangle Sides

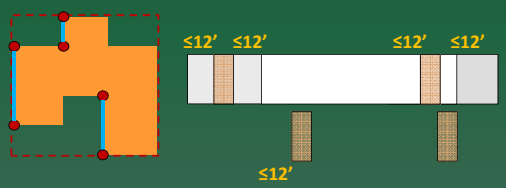


71



Distribution Rule 1

- BWPs located ≤ 12’ from house corner

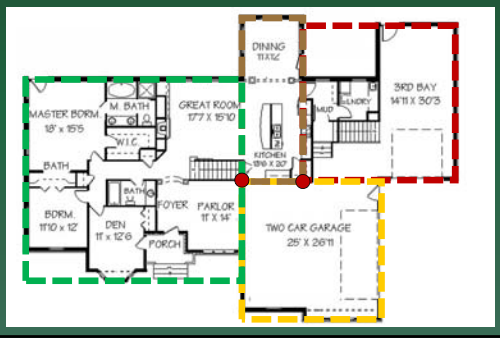


R602.12.6 #1

79

Distribution Rule 1

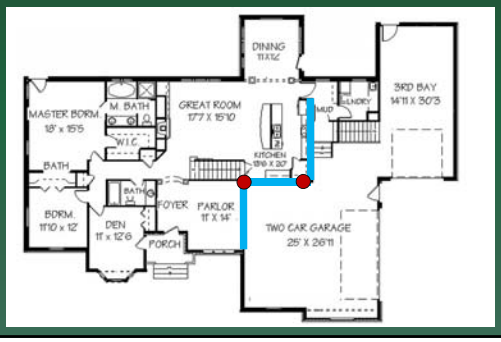
- BWPs located ≤ 12’ from interior rectangle corner



80

Distribution Rule 1

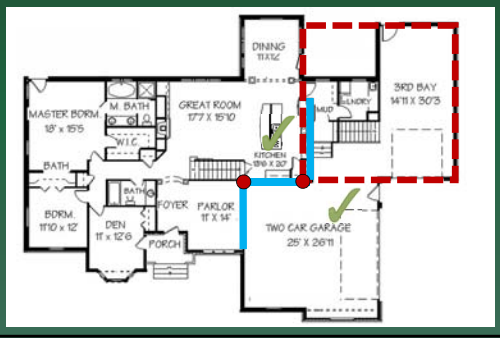
- BWPs located ≤ 12’ from interior rectangle corner



81

Distribution Rule 1

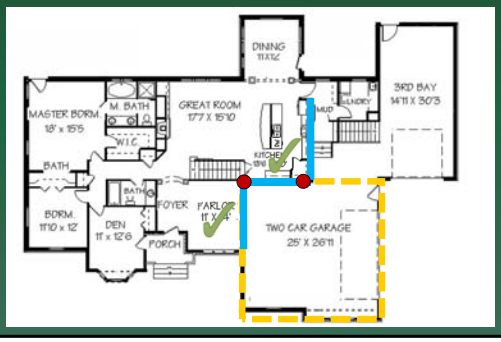
- BWPs located ≤ 12’ from interior rectangle corner



82

Distribution Rule 1

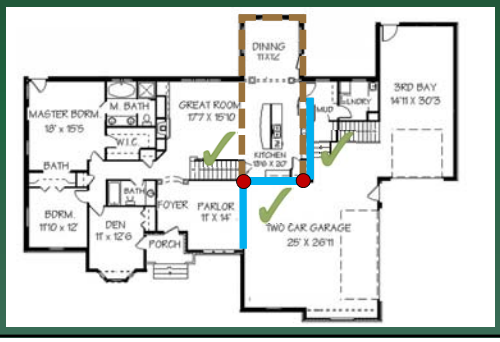
- BWPs located ≤ 12’ from interior rectangle corner



83

Distribution Rule 1

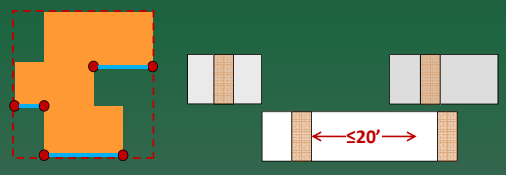
- BWPs located ≤ 12’ from interior rectangle corner



84

Distribution Rule 2

- Edge to edge distance between adjacent BWPs ≤ 20’

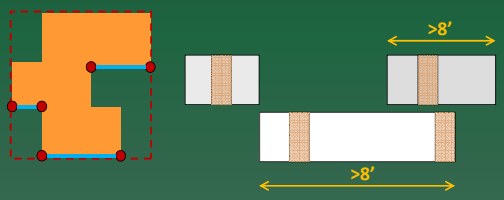


R602.12.6 #2

85

Distribution Rule 3

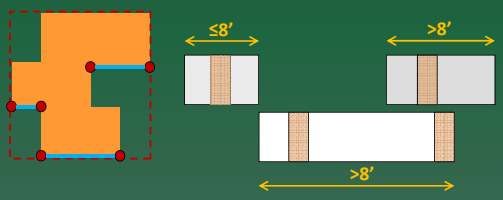
- Wall > 8’ require at least one BWP



R602.12.6 #3 86

Distribution Rule 4

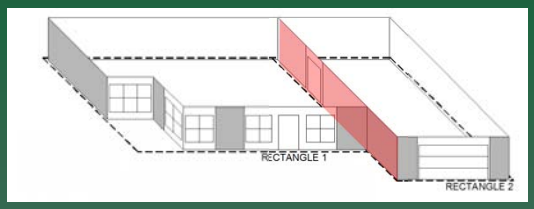
- Wall > 8’ require at least one BWP
- Walls ≤ 8’ are permitted no BWPs



R602.12.6 #4 87

Distribution Exception

- Distribution rules for interior and exterior common walls can be analyzed independently



R602.12.6 88

BWPs Adjacent Balloon-Framed Walls

- Balloon framed walls:
  - Two story foyers
  - Family rooms
- BWP locations
  - Each side of two story portion
  - Each floor

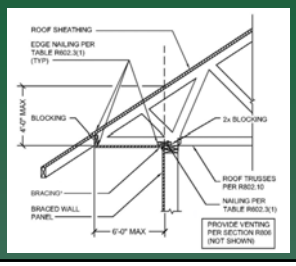
R602.12.6.1

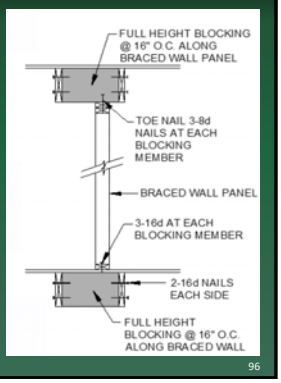
BWPs Adjacent Balloon-Framed Walls

R602.12.6.1 90

BWP Connections

- Refer to R602.10.8
- Connections to framing
- Connections to roof

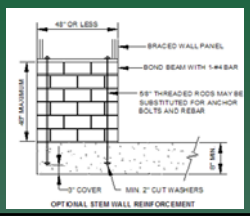




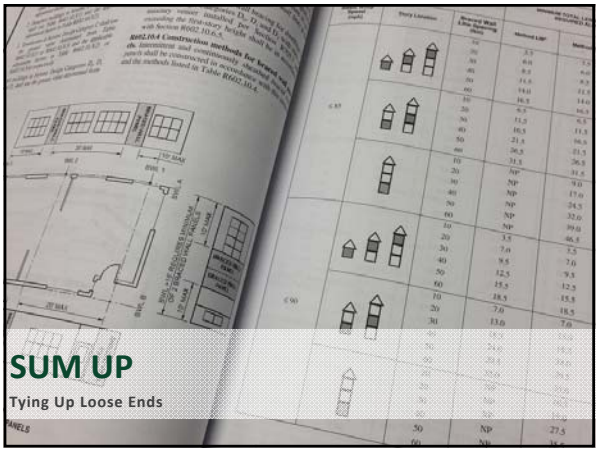
96

BWP Support

- Refer to R602.10.9
- Cantilevered floor restriction
- Masonry stem walls



97



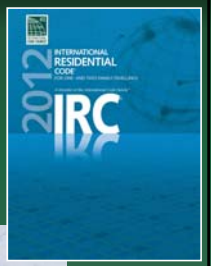
Classic vs. Practical

R602.10	R602.12
8 materials	3 materials
4 narrow methods	4 narrow methods
Unlimited size houses	Unlimited size houses
Braced wall panels	Braced wall panels
Braced wall lines	Circumscribed rectangles
All detached homes	All detached homes
All townhouses	Townhouses in SDC A & B only
End conditions	No end conditions
BWPs 10' from BWL end	BWPs 12' from all house/rectangle corners
Greater flexibility	Easier application
Nationwide	Virginia only

104

Other Prescriptive Methods Accepted

- APA Simplified Wall Bracing
- IRC Simplified Wall Bracing (national version)



105

Wall Bracing Omissions

- Construction conditions not addressed in IRC
- Sheath the following:
  - Gable end walls
  - Gable dormers
  - Narrow shed dormers
- Treat the following as full wall or part of BWL:
  - Full width shed dormers

106

Publications

- *Guide to the 2012 IRC Wall Bracing Provisions* (APA)
- *Wind Bracing* (Fairfax County)
- *Prescriptive Design Guide* (Simpson Strong Tie)
- *IRC Wall Bracing Guide for Builders, Designers and Plan Reviewers* (Foam Sheathing Coalition)
- Notes from this class (available *on fairfaxcounty.gov*)

107

Resources

- Chuck Bajnai, 804 717 6428, *bajnaic@chesterfield.gov*
- Brian Foley, 703 324 1842, *brian.foley@fairfaxcounty.gov*
- APA – The Engineered Wood Association, 253 620 7400, *apawood.org*
- Simpson Strong Tie, (800) 999 5099, *strongtie.com*
- ICC ES, 1 800 423 6587 x66546, *icc es.org*

108

109